

ORIGINAL REPORT

APPLICATION AND VALIDATION OF THE BARROW NEUROLOGICAL INSTITUTE SCREEN FOR HIGHER CEREBRAL FUNCTIONS IN A CONTROL POPULATION AND IN PATIENT GROUPS COMMONLY SEEN IN NEURO-REHABILITATION*

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INTRODUCTION

Objective: To determine whether the Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) can differentiate brain-dysfunctional patients from controls.

Design: A case-control study.

Subjects: A total of 92 controls and 120 patients from a neuro-rehabilitation clinic with a diagnosis of: right and left hemisphere stroke, traumatic brain injury, Parkinson's disease or anoxic brain damage.

Methods: The BNIS has a maximum total score of 50 points, <47 indicates cognitive dysfunction. Group comparisons and exploration of variables influencing the BNIS total score were made.

Results: A significant difference was found between the control group and the total patient group for the BNIS total score and for the subscales ($p < 0.0005$). Sensitivity was 88% and specificity 78%. Presence of disease and educational level had the greatest influence on the results of the BNIS. Patients with Parkinson's disease were shown to be the least cognitively affected and those with anoxic brain damage the most affected.

Conclusion: The BNIS has potential value as a screening instrument for cognitive functions and is sufficiently sensitive to differentiate brain-dysfunctional patients from a control population. It appears to be applicable in a neurological rehabilitation setting, and can be used early in the process, giving a baseline cognitive functional level.

Key words: BNIS, cognition, stroke, traumatic brain injury, anoxia, Parkinson's disease, neuro-rehabilitation.

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Screening cognitive functions can help in assessing the extent and severity of brain damage and thus can serve as a basis for planning and establishing rehabilitation goals (1). Neuropsychological examination usually uses a comprehensive test battery to cover many different cognitive functions to assess the severity of, or reduction in, affected abilities compared with reference values or expected criteria of normal performance. This is time-consuming and, thus, expensive. In addition, in the acute phase, the patient may be too ill and the impact of the disease or injury on regulation of mental energy too severe for the patient to reliably take part in a lengthy evaluation, and this could influence the results. The patient's possible confusional state and ability to communicate and participate in a demanding examination should be considered. There is therefore a need for cognitive screening tests that can be used in such difficult situations to obtain a cognitive baseline conveniently and rapidly, to examine whether the disease or injury has also affected neuropsychological functions, and to determine whether brain dysfunction might underlie the clinically observed symptoms. In the neurological clinic or when the diagnosis is known, it can be of value to use a cognitive screening test to follow the patient's improvement and recovery over time. For realistic goal formulation in neuro-rehabilitation, as well as for follow-up of rehabilitation outcomes, using cognitive screening may be sufficient until more comprehensive testing is needed. The different aims of cognitive screening or examination also determine which objectives and demands are to be met by the test.

During the past decades, several cognitive screening tests have been developed. The qualitative aspects of these have been discussed elsewhere (2–4). Results are often presented as a total score, yielding a cut-off score to estimate the probability of dysfunction. Although the validity, reliability and sensitivity of these tests are estimated to be reasonable for the stated purpose, as a brief screening tool they are considered capable only of increasing the suspicion of neuropsychological dysfunction.

The Mini Mental Status Examination (MMSE) (5) is commonly used, but has been criticized for its limited sensitivity on some items when correlated with neuropsychological tests and for its inability to generate a cognitive profile (6, 7). The content of the MMSE is also dependent on verbal capacity when areas

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other than language are assessed, while visuo-perceptual and visuospatial functions are sparsely assessed. This might increase the risk of not detecting brain damage causing dysfunction in these cognitive areas. The lack of sensitivity has led to recommendations for use of different cut-off levels (8).

Age and education have been shown to affect screening test performance and results (9–11). In a comparison between the Cognistat and the MMSE, the former was shown to be more sensitive to normal ageing (12). Moreover, education contributed uniquely to a number of the Cognistat subtests as well as to the composite score.

The Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) was developed in order to address assessment needs not covered in most cognitive screening instruments (13). The BNIS starts with 3 pre-screen items that assess the level of arousal, basic communication level and level of co-operation. If the patient passes the pre-screen, the BNIS can be completed. The instrument screens a wide range of neuropsychological functions considered to depend on how brain activity is integrated. Quantitative as well as qualitative information about the patient's level of cerebral functioning is gathered. Different aspects of affective ability and dysfunction associated with brain damage, usually not systematically considered in mental status examinations, are included in the BNIS. Also often overlooked in most neuropsychological tests, but incorporated into the BNIS, is judgement of the patient's own awareness of his or her actual performance. Because the BNIS was designed specifically to assess brain dysfunction, this instrument appears to be a potentially helpful tool for use in the neurological rehabilitation setting. In a study started by Denwall et al. (14) for establishing reference norms for the BNIS in a Swedish population, good correspondence with American results was shown (15). As relatively few subjects in the youngest age group (18–39 years) were included, it was decided that additional younger controls were needed to validate the instrument for a Swedish population.

The principal aim of the present study was to examine how well the BNIS could differentiate patients with diagnoses associated with impaired brain function from a control group in Sweden, thereby further examining the construct and concurrent validity of this screening test. Another aim was to assess whether the profile of cognitive performance using the subscales of the BNIS was related to different diagnosis associated with brain impairment.

MATERIAL AND METHODS

The BNIS (13) is a short screening test developed to assess a variety of cognitive functions that is of importance to evaluate in a neurological setting, as an aid for treatment and rehabilitation planning and for monitoring recovery. The BNIS is constructed to reflect the outcome of a range of higher cerebral functions irrespective of whether the patient has focal, diffuse or lateralized damage. The total score can be seen as an index of overall cognitive function. The BNIS is administered in the form of a standardized booklet, in which the test items are presented on different cards along with standardized verbal instructions according to the manual (15). The BNIS starts with a pre-screen to assess whether the patient is capable of participating in further assessment. Following the pre-screen, the range of higher cerebral functions to be

assessed are: primary and secondary speech and language functions, orientation to person, time and place, left-right orientation, arithmetic skills, constructional praxis and concentration and attention skills. A visual scanning item evaluates hemi-inattention. Visual vigilance and problem-solving when managing visual sequences are also assessed. Basic psychomotor skills, pattern recognition and occurrence of perseveration when copying are also examined. Aspects of verbal and visual learning and memory are assessed and, finally, the BNIS includes items concerning affect – expression, perception and control – as well as awareness vs performance.

Results obtained include a total score (maximum 50 points) based on the pre-screen and the 7 subscale scores (speech and language 15p, orientation 3p, attention/concentration 3p, visual and visuospatial problem solving 8p, memory 7p, affect 4p and awareness 1p). A higher score indicates a higher level of functioning. A cut-off score of < 47 was set for identifying brain dysfunction (16). Administration of the test usually takes approximately 15–30 minutes.

The BNIS manual (15) is available translated into Swedish, and the test has been initially validated for a Swedish population (14). The BNIS has also been used in other cultural settings (17–20) and has functioned well, showing good validity and reliability. According to Prigatano et al. (16), the sensitivity of the BNIS was 92% and the specificity 56% when brain-damaged patients were compared with controls. In the Swedish study (14) the sensitivity was 83% and the specificity 46%.

Subjects

The following applies to all cases in the control group ($n = 92$). The subjects were divided into the following age groups according to the BNIS manual: 15–39 years, 40–59 years and 60–84 years. The level of education was categorized in 2 groups. Following the norms of the Swedish educational system, people with 9 years of education ("compulsory school") or less were classified as having a low level of education and those with more than 9 years of education as having a high level of education.

Control group

The controls, mainly staff of different vocational categories within a university hospital setting, were recruited via direct contact person to person or via their work manager. Those asked via the work manager and interested to take part in the study, had to contact the research team in order to be more fully informed about the study. They were provided with written information and participation was voluntary. The study was approved by the ethics committee at Göteborg University. All participants gave their written informed consent.

A total of 114 people agreed to participate. Inclusion criteria were: no history of brain dysfunction, no psychiatric illness or substance abuse, no dyslexia, having Swedish as first language, no serious visual or hearing impairment and no acute illness (the same exclusion criteria as in the study by Denwall et al. (14)). Being a native speaker of Swedish was considered important in order to avoid bias in the results due to misinterpretation of language items and verbal expressions.

Twenty-two subjects were later excluded as they did not fulfil the inclusion criteria (first language other than Swedish; $n = 8$, history of commotio cerebri; $n = 8$, history of migraine; $n = 3$, prior heart surgery; $n = 1$, history of encephalitis; $n = 1$ and a drowning accident with coma; $n = 1$). Thus, there was a total of 92 subjects in the final control population. The establishment of the control population was undertaken as part of the process of collecting of data for completing and establishing Swedish reference norms for the BNIS.

Diagnostic groups

The diagnoses chosen were: stroke (divided into right hemisphere stroke (RHS) and left hemisphere stroke (LHS) considered as 2 different groups), anoxic brain injury (after cardiac arrest), traumatic brain injury (TBI) and Parkinson's disease. These are commonly seen in neuro-rehabilitation and are associated with possible cognitive impairments. Data from the diagnostic groups were obtained retrospectively

from consecutively collected clinical data (since the BNIS was used as part of the routine assessments) in the case of the TBI and Parkinson's disease patients. The data from the patients with stroke and anoxic brain injury were taken from participants in research projects (with ethical approval and informed consent).

In order to avoid selection bias, data from 24 consecutive patients in each diagnostic group were used. For the Parkinson's disease group, data were obtained on a first-referral for out-patient rehabilitation and, for the anoxic brain injury group, at follow-up 12 months after cardiac arrest. The 3 other groups were assessed prior to discharge from an in-patient neuro-rehabilitation ward.

Statistics

A case-control design was used in the study. SPSS 12.0 software was used for the statistical calculations. Descriptive statistics was used for the demographic variables age, gender and education and for the results of the BNIS total score and subscales scores. Non-parametric statistics (the χ^2 test, the Mann-Whitney *U* test and the Kruskal-Wallis test) was performed to assess differences within the control group and differences between controls and the total patient group ($n = 120$) for the BNIS total score and subscale scores.

Non-parametric one-way analysis of variance (the Kruskal-Wallis test) was performed to examine if the BNIS total score and subscale scores would differ between the various patient groups. Hierarchical multiple regression was performed to assess the influence of age, gender, education and presence of disease on the BNIS total score in the control group and all patients ($n = 212$). The analysis was made according to the default settings in SPSS and outliers were checked for according to the SPSS programme.

RESULTS

Demographic data for the control group and the total patient group are presented in Table I. There was a significant difference in age between controls and patients, the patients being older. There was also a significantly greater proportion of men in the patient group, while there were more women in the control group. More patients were low educated compared with the controls (Table I).

Within the control group there was no significant difference in the BNIS total score between men and women ($p = 0.61$, Table II) or between the 3 age groups (Kruskal-Wallis test: $p = 0.72$): 15–39 years (median 48.0, quartiles 47.0–49.0), 40–59 years (median 48.0, quartiles 47.0–49.0), 60–89 years (median 47.5, quartiles 45.25–49.0). Considering educational level in the control group, there was a significant difference in total BNIS score between the groups with a low level of education and those with a high level ($p < 0.0005$, Table II).

Table I. Demographic data for the control group and the total patient group

	Controls ($n = 92$)	Patient group ($n = 120$)	<i>p</i> -value
Gender (<i>n</i>)			
Men/women	41/51	86/34	< 0.0005*
Age, mean (years)	43	51	< 0.0005†
SD (range)	13.0 (19–69)	13.3 (18–74)	
Education (<i>n</i> (%))			
Low level (≤ 9 years)	14 (15)	49 (41)	< 0.0005*
High level (> 9 years)	78 (85)	71 (59)	

* χ^2 test.

†Mann-Whitney *U* test.

Table II. Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) total score in the control group vs the total patient group as a function of gender and different age and educational levels

	Controls ($n = 92$)	Patient group ($n = 120$)	<i>p</i> -value*
Gender			
Men (<i>n</i>)	41	86	
BNIS total score			
Mean (SD)	47.3 (2.2)	39.2 (6.9)	
Median (quartiles)	48.0 (46.0–49.0)	41.0 (37.0–44.0)	< 0.0005
Women (<i>n</i>)	51	34	
BNIS total score			
Mean (SD)	47.7 (1.7)	41.4 (6.3)	
Median (quartiles)	48.0 (47.0–49.0)	43.5 (38.0–46.0)	< 0.0005
Age < 55 years (<i>n</i>)	70	57	
BNIS total score			
Mean (SD)	47.6 (1.9)	40.3 (6.9)	
Median (quartiles)	48.0 (47.0–49.0)	42.0 (37.5–44.0)	< 0.0005
Age > 55 years (<i>n</i>)	22	63	
BNIS total score			
Mean (SD)	47.3 (2.3)	39.4 (6.8)	
Median (quartiles)	47.5 (46.0–49.0)	42.0 (37.0–44.0)	< 0.0005
Low level of education (≤ 9 years) (<i>n</i>)	14	49	
BNIS total score			
Mean (SD)	45.3 (2.3)	37.4 (7.4)	
Median (quartiles)	45.0 (43.75–47.0)	40.0 (34.0–42.5)	< 0.0005
High level of education (> 9 years) (<i>n</i>)	78	71	
BNIS total score			
Mean (SD)	47.9 (1.7)	41.5 (6.1)	
Median (quartiles)	48.0 (47.0–49.0)	43.0 (39.0–45.0)	< 0.0005

*Mann-Whitney *U* test.

In the total patient group there were no differences in BNIS total score with respect to gender ($p = 0.53$, Table II) and the 3 age groups (Kruskal-Wallis test: $p = 0.718$: 15–39 years (median 40.0, quartiles 37.0–44.0), 40–59 years (median 41.0, quartiles 38.0–45.0), 60–89 years (median 41.5, quartiles 37.0–44.0), whereas there was a significant difference between the 2 levels of education ($p < 0.0005$, Table II).

When comparing the controls and the total patient group ($n = 120$) with respect to gender, it was shown that in the patient group men as well as women scored significantly lower than the control group (Table II). A division of age into “younger” (age below 55 years) and “older” (age 55 years and above) subjects was also made and comparison showed a significant difference in the BNIS total score between the controls and the patient group, both among those below and those above age 55 years where the patients had a lower score (Table II). A similar division was made concerning education. The subjects with a low level of education in the control group and with a low level of education in the total patient group differed significantly in the BNIS total score. The same result was found when the subjects with a high level of education were compared; the patients scored lower than the controls (Table II).

The sensitivity of the BNIS in differentiating brain-damaged patients from controls was 88% and the specificity was 78%. The false positive ratio was 22% and the false negative ratio was 12% (14 patients were misclassified).

Table III. Means, standard deviations (SD), medians and quartiles of the Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) total score and subscales in the control group and the total patient group

BNIS	Controls n = 92			Patients n = 120			p-value
	Mean (SD)	Median	Quartiles	Mean (SD)	Median	Quartiles	
Total score	47.5 (2.0)	48.0	47.0–49.0	39.8 (6.8)	42.0	37.0–44.0	< 0.0005*
Speech and language	14.9 (0.3)	15.0	15.0–15.0	13.4 (2.2)	14.0	13.0–15.0	< 0.0005*
Orientation	3.0 (0)	3.0	3.0–3.0	2.6 (0.7)	3.0	2.0–3.0	< 0.0005*
Attention	2.5 (0.7)	3.0	2.0–3.0	2.0 (0.9)	2.0	1.0–3.0	< 0.0005*
Visuospatial problem-solving	7.2 (0.8)	7.0	7.0–8.0	5.4 (1.6)	6.0	4.0–7.0	< 0.0005*
Memory	6.5 (1.1)	7.0	6.0–7.0	3.9 (2.2)	4.0	2.0–6.0	< 0.0005*
Affect	3.7 (0.6)	4.0	3.0–4.0	3.2 (0.9)	3.0	3.0–4.0	< 0.0005*
Awareness vs performance, proportion correct	0.8			0.4			< 0.00006†

*Mann-Whitney U test.

†Difference between proportions.

There were significant differences between the control group and the total patient group in BNIS total score as well as in all subscales (Table III, Figs 1 and 2).

The patients with Parkinson’s disease were the least cognitively affected, while the most severe cognitive dysfunction was found in the group with anoxic brain injury (Table IV). The results also showed that the anoxic brain injury group had the most reduced scores on all subscales (mean values) and thus were shown to have the greatest impact on cognitive function after brain damage. However, when using median values, 4 groups had the same median in the speech and language subscale. An analysis of the RHS and LHS groups, demonstrated a significant difference in the speech and language ($p = 0.043$) and in the attention subscale ($p = 0.005$), the LHS patients scoring lower than the RHS patients. Otherwise there were no significant differences between the 2 stroke groups. There was a tendency towards a lower performance in the visuospatial subscale for the RHS group. Of these patients, 38% received

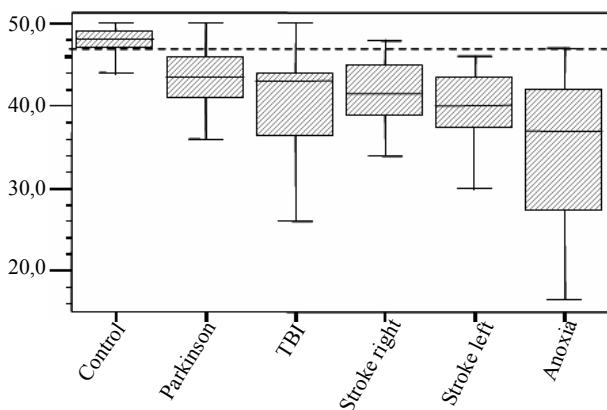


Fig. 1. Box plots showing the results of Barrow Neurological Institute Screen for Higher Cerebral Functions total score in the control group ($n = 92$) and in the different patient groups. Median (line in box), 25th and 75th percentile (lower and upper ends of box) and lowest and highest value (whiskers) are presented. TBI: traumatic brain injury.

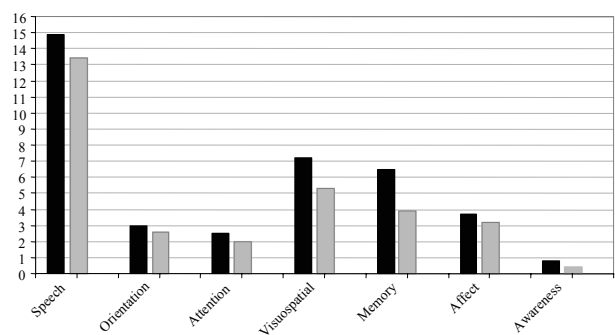


Fig. 2. Bar chart of the subscale scores of the Barrow Neurological Institute Screen for Higher Cerebral Functions. Controls (■) ($n = 92$) and total patient group (▒) ($n = 120$). The group mean value for each subscale is shown.

a score between 1 and 4, compared with 25% of the patients with LHS. The TBI group seemed to be an intermediate group, the most common cognitive dysfunctions being problems with orientation, memory and awareness. Although the Parkinson’s disease group was the least affected, problems with attention/concentration were noted.

In conclusion, there were significant differences between the patient groups in total score and in 6 of the subscales of the BNIS. The subscale of visuospatial and visual problem-solving almost reached significance (Table IV).

Hierarchical multiple regression analysis of the controls and total patient group showed that presence of disease had the most impact on the variability in the BNIS total score and, together with educational level, significantly ($p < 0.0005$) explained 40.7% of the variance (Table V). Age and gender were also included in the regression model, but did not contribute significantly. One subject was identified as an outlier, but was kept in the data as the Cooks distance maximal value was 0.70. When analysed separately, all the different diagnostic groups showed similar patterns regarding influence of disease and education level; these 2 variables explained between 41.4% and 63.6% of the variance in BNIS total score, while age and gender were not significant.

Table IV. Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) total score and subscale scores: mean values and standard deviations (SD) for the different patient groups. Result of the Kruskal-Wallis test

BNIS	RHS n = 24		LHS n = 24		Anoxia n = 24		TBI n = 24		Parkinson n = 24		Kruskal-Wallis	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	χ^2	p-value
Total score	41.5	4.6	39.2	5.8	35.0	8.6	39.8	7.5	43.5	3.6	18.36	0.001
Speech	13.9	1.3	13.1	1.7	12.5	13.1	13.1	2.9	14.5	0.7	16.36	0.003
Orientation	2.8	0.4	2.8	0.6	2.1	0.9	2.5	0.7	2.9	0.3	17.55	0.002
Attention	2.5	0.7	1.9	0.8	1.4	0.9	2.1	0.7	2.1	0.8	18.90	0.001
Visuospatial	5.0	1.6	5.3	1.6	4.7	1.9	5.8	1.6	6.0	1.1	9.27	0.055
Memory	4.5	1.9	3.9	2.1	2.4	2.2	3.8	2.5	4.8	1.8	15.14	0.004
Affect	3.5	0.7	3.2	0.8	2.8	1.0	3.3	1.0	3.5	0.7	11.32	0.023
Awareness (proportion correct)	0.4		0.3		0.2		0.3		0.7		15.87	0.003

RHS: right hemisphere stroke; LHS: left hemisphere stroke; TBI: traumatic brain injury.

DISCUSSION

Main results of the study

The main goal of this study was to determine whether the BNIS could differentiate patients with a diagnosis associated with brain-dysfunction from controls. The results showed a significant between-group difference and good sensitivity and specificity. We were also able to describe some differences in cognitive profile between the diagnostic groups tested; the total BNIS score, as well as performance assessed with the BNIS subscales, varied across the groups.

Control group

In this setting, no significant difference was found in the total BNIS score between men and women or between the age groups in the control group. The latter result could partly be explained by the fact that the control group did not include individuals > 70 years of age; thus, the present control population differs from those investigated in previous studies from Sweden and the USA (14, 15). However, in line with other studies (11, 15), we noted a significant difference in the BNIS scores between low and high educational levels in the control group.

Patient groups

Most prior studies using the BNIS (17–21) have used a heterogeneous study population with a mix of brain damage diagnoses and different diagnostic group sizes. In these studies significant

differences were found between the control population and patients, as in our study.

Despite the rather small number of patients per diagnostic group ($n = 24$), we were able to note differences in the BNIS subscales. As expected, the left hemisphere stroke patients differed from the right hemisphere damaged on the speech and language subscale. The right hemisphere stroke patients had a tendency to obtaining lower scores on the visual and visuospatial problem-solving subscale. Patients with Parkinson's disease were the least cognitively affected group on all subscales except attention and concentration. This is in fairly good accordance with a recent study (22), which showed that immediate memory and executive function were impaired in the Parkinson's disease group. In order to use one's memory and rely on executive functions, a certain basic attention capacity is needed. Anoxic brain injury patients were the most affected on all subscales and, according to our results, also in speech and language (mean values). This is not too surprising, as anoxia can result in diffuse global brain damage, often affecting the hippocampus as well. Clinical experience with this patient group shows that language is often well preserved (7), which might mask the consequences of brain damage. In this study, a few anoxic brain injury patients were very severely impaired. This probably explains the surprising finding of a low mean score for the speech and language subscale in this group. In the present study, the TBI group consisted mostly of patients with moderate brain injury. Compared with the results of an American study of moderate TBI patients ($n = 22$) (23) our TBI patients' scores were lower on the memory subscale and higher on the speech and language subscale. Because the number of TBI patients was low in both studies, we do not know whether this discrepancy is due to patient selection or to socio-cultural differences. In contrast to most other studies, we held the number of patients in each diagnostic group constant in order to minimize the influence of group size. We believe that this strengthens the results presented above and supports the findings of differentiation potential.

Explanatory factors – findings in this study

The results of the hierarchical multiple regression analysis indicated that the presence of a diagnosis carried the most

Table V. Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) total score. Hierarchical multiple regression analysis: control group ($n = 92$) and total patient group ($n = 120$)

Variable	Parameter estimate	CI (95%)	p-value	R ² change	R ²
Age	-0.006	-0.060–0.048	0.82	0.202	0.205
Gender	0.858	-0.620–2.335	0.25		
Education (low-level/high-level)	3.420	1.791–5.050	<0.0005		
Presence of diagnosis	-6.538	-8.062–5.014	<0.0005	0.205	0.407

CI: Confidence interval.

weight in explaining the variability of the BNIS total score, but education also contributed. Educational level might also have an influence on the result of the subscales. That level of education influenced the BNIS scores in controls as well as in the patient groups confirms prior results (14, 24). By comparing the results of the BNIS total score of the controls and the patients on the same educational level, age and gender we tried to control for skewness and uneven distribution in these variables. However, there were still significant differences in the BNIS total score between the controls and the patients of the same educational level and when compared with respect to gender and in 2 age groups. Suggestions for future studies with the BNIS include examining whether educational level should be considered, as has been done for Cognistat (12) and, if so, developing reference norms for the BNIS that are stratified for educational level.

In conclusion, the results of this study indicate that the BNIS subscales can identify differences in cognitive performance in different diagnoses commonly seen in neuro-rehabilitation. This can be of help when planning further neuropsychological examination and designing training programmes for the restoration of cognitive function. This information can be of value when guiding and supporting the patient and the caregiver through the rehabilitation process. An extensive neuropsychological test battery can be exhausting for the patient to perform, and cannot be used repeatedly. As a screening instrument is briefer it can be used early, even at the bedside, in the acute phase after illness or injury. It is also convenient to use for assessing rate of recovery during follow-up. Besides considering the patient effort of taking a complete test, financial costs and time consumption should also be considered. These costs are much lower for a screening test than for an extensive neuropsychological examination. In addition, as the progress of the recovery is often faster during the first months after injury, it might be sufficient to use cognitive screening during this period. However, it must be remembered that a screening instrument reflects basic ability, and a more detailed neuropsychological examination is needed for the assessment, description and understanding of the complexity and more subtle aspects of cognitive function and dysfunction.

In conclusion, based on the results of this study, we believe, that the BNIS is a useful screening tool for cognitive function in the clinical setting. Our results confirm those of prior studies (17, 18). The test can be administered reasonably quickly and can identify cognitive dysfunction associated with brain injury with good sensitivity. The subscales also enable identification of the cerebral functions most affected in the brain-damaged patient. The test covers several cognitive domains, which also makes it feasible for use in testing people with diffuse damage and those with right-sided brain damage, as well as those with speech and language difficulties, if these are not too pronounced. It is also useful in identifying brain dysfunction masked by good speech ability, such as in anoxic brain injury.

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