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Neurocognitive diagnosis and cut-off scores of the Screen for Cognitive Impairment in Psychiatry (SCIP-S)

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ABSTRACT

Objectives: To demonstrate the ability of the Screen for Cognitive Impairment in Psychiatry (SCIP-S) to discriminate between cognitively-impaired individuals and those with adequate functioning in a sample of schizophrenic and bipolar patients, as well as in a control group.
Methods: The SCIP-S, together with a full neuropsychological battery, was administered to three groups: patients with schizophrenia, patients diagnosed with bipolar disorder I, and controls. The battery scores were used to perform a standardization with respect to the control group and this served to determine the comparison groups (cognitively impaired versus unimpaired) for each of the subtests of the SCIP-S. A full analysis of decision validity was conducted on the basis of receiver operating characteristic curves (sensitivity and specificity, +LR and −LR, PPV and NPV).
Results: All the subtests yielded adequate values for sensitivity and specificity with the proposed cut-off points, while the total score of the SCIP (<70) was associated with a sensitivity of 87.9 and specificity of 80.6.
Conclusions: The SCIP-S shows adequate decision validity as a screening tool for cognitive deficit in patients diagnosed with schizophrenia or bipolar disorder.

1. Introduction

Cognitive impairment in schizophrenia and bipolar disorder is important due to the repercussions it has on the diagnostic, therapeutic and rehabilitative process. Indeed, its presence and the degree and type of deficit have a key influence on many clinical decisions and care management

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plans, since such impairment determines the patient's autonomy in a number of functions and capacities, including illness awareness, therapeutic compliance, and the inability to remember medical appointments or various aspects of psychosocial functioning (Green, 1996; Tabarés-Seisdedos et al., 2008).

The importance of this aspect has given rise to a large body of research which has described different types of neuropsychological deficit and degrees of impairment. Patients with schizophrenia and bipolar disorder exhibit a wide range of cognitive deficits (Table 1), but the same underlying factor structure describes their neuropsychological functioning in both groups. However, the profile of impairment varies between schizophrenic and bipolar disorders, with the schizophrenic patients having a worse functioning (Czobor et al., 2007).

Also, the heterogeneity of the type and degree of deficit, influenced by the different patterns of cognitive impairment and the phase of the disease process (Saykin et al., 1994), makes it necessary to apply exhaustive and detailed test batteries, and to use numerous specialized tools for measuring or detecting different cognitive abilities that are impaired in some patients but not in others. Recently, the MATRICS (Measurement and Treatment Research to Improve Cognition in Schizophrenia) initiative of the National Institute of Mental Health (Green and Nuechterlein, 2004; Kern et al., 2004) has sought to unify and standardize the type of deficits to be measured and the tests to be used with the objective of developing new and effective treatments for the neurocognitive deficits suffered by schizophrenic patients.

Currently, the various cognitive functions proposed by MATRICS (Nuechterlein et al., 2004) are assessed by specialists using neuropsychological batteries that take at least 60–120 min to administer. Furthermore, the tools used are mostly derived from traditional neuropsychology and have not been specifically adapted or normed for a psychiatric population. This is problematic not only in terms of the potential difficulties with evaluating or interpreting some of the functions assessed, but also because such tests are difficult to administer in large patient or population samples, which require more cost-effective screening tools.

The tools used to support clinical decision-making must be studied as regards their decision validity and corresponding sensitivity and specificity, as well as their optimum cut-off points, all of which are key aspects when it comes to making accurate diagnoses. In this regard, an analysis based on the receiver operating characteristic curve (ROC; Metz, 1978) aims to evaluate the ability of a test to discriminate between alternative states of health or conditions of individuals (i.e., diagnostic accuracy), and in so doing it enables more accurate decisions to be made following test administration.

Table 1
Types of cognitive deficit (adapted from Harvey and Sharma, 2002).

Cognitive deficit
Attention–vigilance
Distractibility
Executive functions
Motor Speed
Naming
Perceptual skills
Recall memory
Recognition memory
Verbal fluency
Verbal learning
Visuo-motor skills
Working memory

In recent years a number of scales designed specifically for the psychiatric population and which are quicker to administer than traditional batteries have been developed, and these have shown adequate psychometric properties of reliability and validity. Examples include Cognistat (Kiernan et al., 1987), the Brief Cognitive Assessment (BCA; Velligan et al., 2004), the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph et al., 1998), the Brief Assessment of Cognition in Schizophrenia (BACS; Keefe et al., 2004), and the Screen for Cognitive Impairment in Psychiatry (SCIP; Purdon, 2005). Although the psychometric properties of these instruments have been extensively evaluated in various clinical samples (Eisenstein et al., 2002; Engelhart et al., 1999; Garcia et al., 2008; Guilera et al., 2009; Hill et al., 2008; Hobart et al., 1999; Keefe et al., 2008; Pino et al., 2008; Wilk et al., 2002), few studies have conducted a detailed analysis of their sensitivity and specificity. The exceptions include a ROC curve analysis of Cognistat in brain-damaged patients (Nøkleby et al., 2008) and of the RBANS in patients with Alzheimer's disease (Duff et al., 2008), but diagnostic validity has yet to be explored in psychiatric patients or for the other tests mentioned above. The SCIP is a simple and easy-to-administer instrument designed with the intention to assess cognitive impairment in psychiatric patients. The subtests within the SCIP quantify immediate and delayed verbal list learning, working memory, verbal fluency and psychomotor speed, all of which may be impaired in schizophrenia or bipolar disorders. The SCIP has been shown to be valid and reliable in both its English and Spanish versions (Guilera et al., 2009; Pino et al., 2006, 2008), but its decision validity has not yet been analyzed. The aim of the present study is to explore the ability of the SCIP to distinguish between individuals with and without cognitive impairment.

2. Methods

2.1. Samples

There were a total of 277 participants consisting of 123 patients with a schizophrenia spectrum disorder (108 schizophrenia, 13 schizoaffective disorders, and 2 schizophreniform disorders), 75 with bipolar disorder I, and 79 healthy controls statistically matched to both patients' samples by sex, age, and educational level. The average duration of illness in the 123 schizophrenic patients was 145.3 (SD = 95.1) months, and the average number of prior hospital admissions was 2.6 (SD = 3.7). Most of the patient sample were being treated with a single antipsychotic medication (68.3%), although many were receiving a combination of two (25.2%), and a small proportion were receiving three antipsychotic drugs (4.9%). Only 2 patients (1.6%) were not receiving antipsychotic treatment at the time of the assessment. In addition to antipsychotic medication, 73 patients (59.3%) were receiving adjunctive treatment, primarily antidepressants and benzodiazepines.

The bipolar I sample had a mean illness duration of 147.4 (SD = 97.5) months. They had experienced an average of 4.4 (SD = 3.4) manic episodes, 4.3 (SD = 4.5) depressive episodes, and 3.3 (SD = 4.3) hospital admissions. At the time of cognitive assessment, patients were on lithium (28.0%), lithium plus one antipsychotic (41.3%), lithium plus two antipsychotics (4.0%), one antipsychotic medication (16.0%), two antipsychotics (2.7%) or three antipsychotics (1.3%). Five patients were free of lithium and antipsychotics. Fifty-two patients (69.3%) were also receiving adjunctive treatment, primarily with antidepressants or benzodiazepines. Additional characteristics of the three samples are shown in Table 2.

2.2. Instrument

The SCIP was designed to detect cognitive deficits in several psychotic and affective disorders. It can be administered without the need for additional equipment (only pencil and paper) and requires around 15 min to complete. Three alternative forms of the scale are available to facilitate repeated testing while minimizing learning effects. The SCIP includes a Verbal Learning Test-Immediate (VLT-I), a Working Memory Test (WMT), a Verbal Fluency Test (VFT), a Verbal Learning Test-Delayed (VLT-D), and a Processing Speed Test (PST). The original version of the SCIP is in English (Purdon, 2005), while the rationale, development and translation of the Spanish adaptation (SCIP-S) was described in a previous publication (Pino et al., 2006). The SCIP-S has shown adequate psychometric properties for detection of cognitive impairment in patients with schizophrenia (Pino et al., 2008) and type I bipolar disorder (Guilera et al., 2009).

2.3. Procedure

The study was approved by the Ethics Committee of the University of Barcelona, and all subjects provided written informed consent to participate. Data were collected in the outpatient facilities of forty hospitals across Spain by 44 psychiatrists and 41 neuropsychologists. The corresponding clinical diagnosis was established by experienced psychiatrists according to DSM IV-TR criteria (American Psychiatric Association, 2000) and the neuropsychological examination was carried out by qualified neuropsychologists. Schizophrenic patients were 18–55 years of age and in a stable phase of the illness defined by no hospitalization in the past 3 months, a total score under 70 on the Positive and Negative Syndrome Scale (PANSS, Kay et al., 1986; Peralta and Cuesta, 2004), a score under 3 on all seven positive symptom items of the PANSS (delusions, conceptual disorganization, hallucinations, agitation, grandiosity, suspiciousness, and hostility), and no changes in drug regimen or dose during the study. Bipolar patients were also 18–55 years of age and in a stable phase of the illness defined by at least 6 months in remission, a Young Mania Rating Scale (YMRS; Young et al., 1978) score less than 6, and no required changes in the type or dose of psychopharmacological treatment for the duration of the study. In both samples, we controlled that a Hamilton Depression Scale (HAMD; Hamilton, 1960) score less than 8 and subjects with severe or unstable medical or neurological problems, illiterate, other primary psychiatric disorders including major depression, or ongoing participation in a clinical trial were excluded. The control sample was statistically matched to the clinical samples on sex, age, and educational level, and they were free of significant symptoms of psychiatric illness assessed with the interview Comprehensive Assessment of Symptoms and History (CASH; Andreasen et al., 1992). Controls were excluded if they had severe medical or neurological problems, met criteria for a psychiatric disorder, were participating in a clinical trial, were illiterate, or having any first degree relative with mental illness. More detailed information about the recruitment process is given elsewhere (Guilera et al., 2009; Pino et al., 2008). Briefly, for this study all participants were administered one of the three alternative forms of the SCIP-S and an extensive neuropsychological battery that included the Wechsler Adult Intelligence Scale-III (Wechsler, 1999) subscales corresponding to Symbol Search, Digit Symbol-Coding, Arithmetic, Digit Span, and Letter/Number Sequencing; the Wechsler Memory Scale-III (Wechsler, 2004) subscales corresponding to Word List I and Word List II; the Trail Making Test (TMT A and B; Army Individual Test Battery, 1944); and a test of semantic fluency (Estes, 1974; Rosen, 1980).

The criterion to differentiate between the cognitively and non-cognitively impaired samples was based on three steps: (i) in each neuropsychological test (see Table 3) the mean *z*

Table 2
Principal demographic and anamnestic characteristics of the diagnostic groups.

Variable	Schizophrenia		Bipolar disorder I		Control group	
	N	%	*N*	%	*N*	%
Sex						
Males	89	72.4	33	44	46	58.2
Females	34	27.6	42	56	33	41.8
Educational level						
Illiterate	0	0	0	0	0	0
Functional illiterate	2	1.6	1	1.3	0	0
Primary education	43	35.0	27	36.0	26	32.9
Secondary education	55	44.7	24	32.0	32	40.5
University education	20	16.3	22	29.3	21	26.6
Other	3	2.4	1	1.3	0	0
Mean age (SD)	123	36.8 (8.4)	75	40.5 (8.9)	79	38.2 (8.6)
Mean duration of illness in months (SD)	123	145.3 (95.1)	75	147.4 (97.5)	–	–
Mean number of prior hospital admissions (SD)	123	2.6 (3.7)	75	3.3 (4.3)	–	–
Mean number of manic episodes (SD)	–	–	75	4.4 (3.4)	–	–
Mean number of depressive episodes (SD)	–	–	75	4.3 (4.5)	–	–

Table 3
Scores on the SCIP-S for the different comparison groups.

SCIP-S subtest	Neuropsychological tests	Group [a]	Source group [b]	Mean	SD	*t* and *d*
VLT-I	Word list I	A	67 (54.5%) S 32 (42.7%) B 13 (16.5%) C	16.96	3.423	$t_{(275)} = 10.807^{*}$ $d = 1.32$
		NA	56 (45.5%) S 43 (57.3%) B 66 (83.5%) C	21.52	3.462	
WMT	Arithmetic, Digit Span, Letters and Numbers	A	64 (52.5%) S 36 (48.0%) B 7 (9.0%) C	15.53	4.112	$t_{(273)} = 8.473^{*}$ $d = 1.05$
		NA	58 (47.5%) S 39 (52.0%) B 71 (91.0%) C	19.33	3.271	
VFT	Semantic fluency	A	57 (46.3%) S 31 (41.3%) B 8 (10.1%) C	13.03	5.294	$t_{(275)} = 6.047^{*}$ $d = 0.76$
		NA	66 (53.7%) S 44 (58.7%) B 71 (89.9%) C	17.29	5.717	
VLT-D	Word list II	A	63 (51.2%) S 39 (52.0%) B 20 (25.3%) C	4.17	2.169	$t_{(275)} = 8.066^{*}$ $d = 0.98$
		NA	60 (48.8%) S 36 (48.0%) B 59 (74.7%) C	6.25	2.087	
PST	TMT-A, Time, Digit Symbol-Coding, Symbol Search	A	93 (76.9%) S 59 (78.7%) B 10 (13.0%) C	8.43	2.580	$t_{(271)} = 12.769^{*}$ $d = 1.57$
		NA	28 (23.1%) S 16 (21.3%) B 67 (87.0%) C	12.47	2.554	
Total SCIP	All tests	A	71 (59.2%) S 41 (54.7%) B 4 (5.3%) C	56.82	11.529	$t_{(269)} = 16.478^{*}$ $d = 2.02$
		NA	49 (40.8%) S 34 (45.3%) B 72 (94.7%) C	77.68	9.293	

VLT-I = Verbal Learning Test-Immediate; WMT = Working Memory Test; VFT = Verbal Fluency Test; VLT-D = Verbal Learning Test-Delayed; PST = Processing Speed Test; Total SCIP = SCIP total score.
* $p < .001$.
[a] A: cognitive affected group; NA: cognitive non-affected group.
[b] S: schizophrenia; B: bipolar disorder I; C: control.

score was established using the corresponding mean and standard deviation of the control group, (ii) in that cases where a SCIP subtest was matched to more than one neuropsychological test (e.g., WMT is in line with Arithmetic, Digit Span and Letters and Numbers, and PST with TMT-A time, Digit Symbol-Coding and Symbol Search) the standardized score was computed averaging the corresponding *z* scores, and (iii) the cut-off point was established at less than 1 standard deviation below the normal mean (Harvey et al., 2006; Taylor and Heaton, 2001). According to this criterion, all individuals were classified as to whether they manifested impairment on each of the different cognitive measures.

2.4. Data analysis

A detailed analysis of decision validity was carried out for each of the five subtests and the SCIP total score to assess the utility of the test to differentiate between cognitively-impaired individuals and those with adequate functioning with respect to the cognitive function measured by the subtest in question. Specifically, an analysis of ROC curves was used to determine the sensitivity and specificity of each subtest and the SCIP total score. The sensitivity indicates the proportion of individuals classified by the SCIP as having cognitive impairment when the neuropsychological battery gives evidence of it, while the specificity reveals the proportion of individuals classified by the SCIP as not having cognitive impairment when they do not actually have it. The positive and negative likelihood ratios (+LR and −LR, respectively) were also computed; the former indicates the ratio between the probability of a positive test result by the SCIP given the presence of cognitive impairment and the probability of a positive test result given the absence of this impairment $\left(+LR = \frac{Sensitivity}{1 - Specificity}\right)$, while the −LR represents the same ratio but with a negative test result $\left(-LR = \frac{1 - Sensitivity}{Specificity}\right)$. Additionally, the corresponding positive and negative predictive values (PPV and NPV, respectively) were computed. The PPV corresponds to the probability of having cognitive impairment if the SCIP gives a positive result, and the NPV indicates the probability of not having cognitive impairment if the SCIP gives a negative result. Finally, the optimum cut-off point was chosen for the subtests and the SCIP total score based on two aspects: a) the SCIP is a screening rather than a diagnostic tool, and thus it is

essential for it to show high sensitivity (around 80% or higher), even if this is to the detriment of its specificity; and b) as far as possible it is important to choose the cut-off point that offers the best balance between the values of sensitivity and specificity. Statistical analyses were performed using SPSS version 15.0 and significance was set at $\alpha = .05$.

3. Results

The mean SCIP subtest and total scores for each group of subjects were calculated after binary stratification based on the impairment demonstrated on traditional neuropsychological instruments within each cognitive domain (see Table 3).

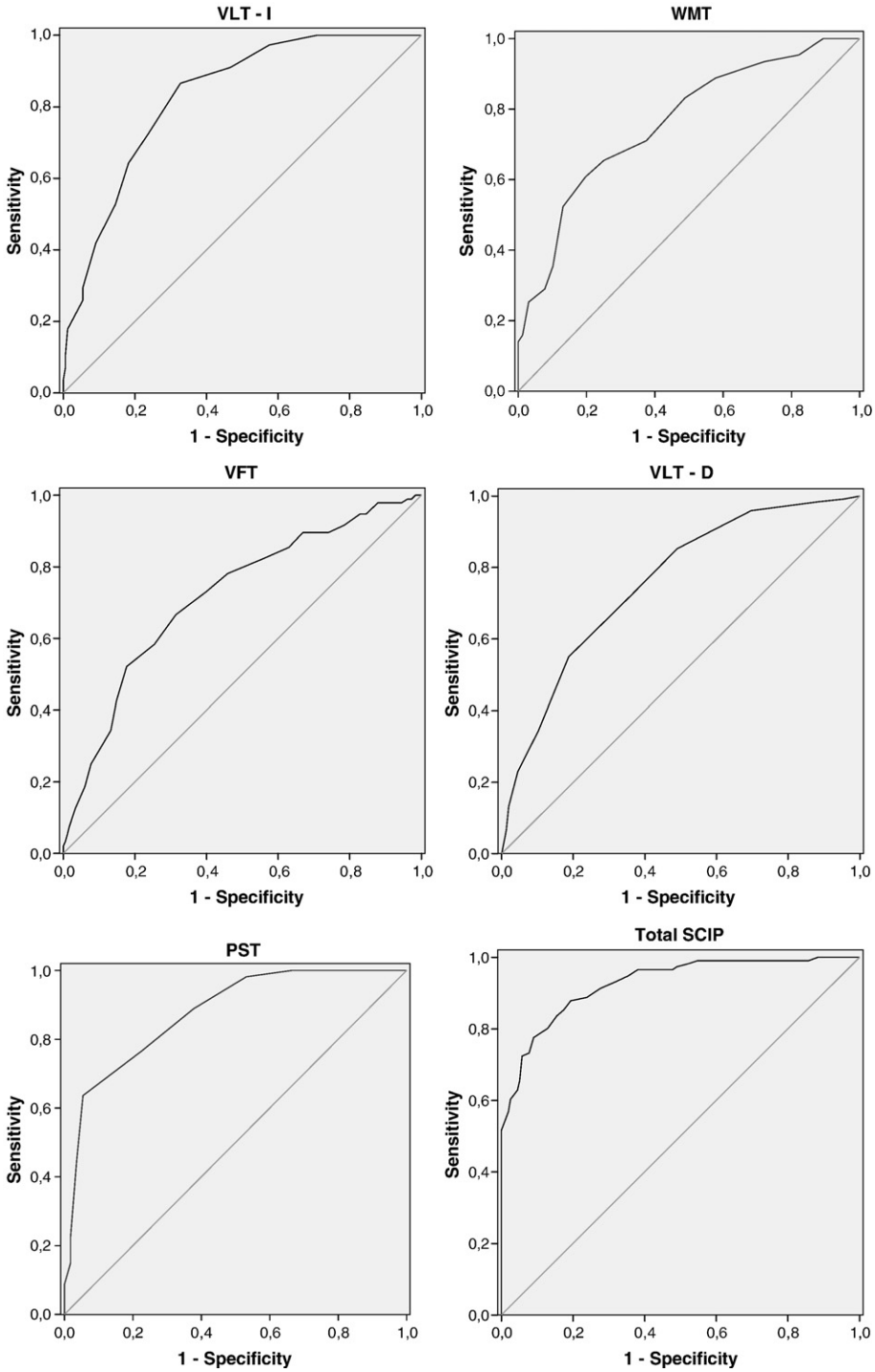

Fig. 1. ROC curves for SCIP subtests and total score. VLT-I = Verbal Learning Test-Immediate; WMT = Working Memory Test; VFT = Verbal Fluency Test; VLT-D = Verbal Learning Test-Delayed; PST = Processing Speed Test; Total SCIP = SCIP total score.

Table 4
Areas under the ROC curve for SCIP subtests and total score.

Subtest	AUC*	95% CI	*p* value
VLT-I	0.829	0.782–0.876	<.001
WMT	0.762	0.704–0.820	<.001
VFT	0.717	0.654–0.781	<.001
VLT-D	0.756	0.700–0.812	<.001
PST	0.875	0.834–0.916	<.001
Total SCIP	0.927	0.897–0.957	<.001

VLT-I = Verbal Learning Test-Immediate; WMT = Working Memory Test; VFT = Verbal Fluency Test; VLT-D = Verbal Learning Test-Delayed; PST = Processing Speed Test; Total SCIP = SCIP total score.
*0.90–1.00 = excellent; 0.80–0.90 = good; 0.70–0.80 = fair; 0.60–0.70 = poor; 0.50–0.60 = fail.

Participants with scores less than 1 standard deviation below the normal mean were assigned to a cognitive affected (A) group, and the remaining participants were assigned to a cognitive non-affected (NA). On all the subtests the group with cognitive impairment included a greater number of patients with schizophrenia or bipolar disorder I than controls. SCIP total scores revealed that only 5.3% of control subjects fell within the impaired group according to the neuropsychological battery, whereas over half the patients diagnosed with schizophrenia and bipolar disorder were classified as cognitively impaired (59.2% and 54.7%, respectively). In all cases the mean SCIP scores for the cognitively-impaired groups were lower than those for non-impaired groups; these differences were significant with effect sizes in terms of *d* values ranging from 0.76 for VFT to 2.02 for SCIP total score (see Table 3). Given that the groups were defined according to the neuropsychological battery it can therefore be highlighted that the subtests of the SCIP differentiate adequately between these types of deficits.

ROC curves were created to assess the sensitivity and specificity of all possible cut-off points for the SCIP subscale and total scores relative to the respective domain scores obtained from the traditional neuropsychological instruments (see Fig. 1).

In general, it can be assumed that better decision performance is indicated by a ROC curve that is higher and to the left in the ROC space. In our example, although on some subtests more than others, the ROC curves show an approximation to this optimal situation. This provides initial evidence that the SCIP subtests and total score are able to distinguish between cognitively-impaired and non-impaired groups.

In all cases the area under the ROC curve was significantly different from 0.5, the value that would have been reached if the SCIP subtest (or total score) could not distinguish between the two groups. Table 4 shows the areas under the ROC curves (AUC), their confidence intervals and the significance test. Specifically, these values ranged between 0.717 for the VFT and up to 0.927 for total score, and three were good to excellent in the traditional AUC scoring system (VLT-I, PST and total score). The latter suggests that the SCIP total score from a randomly-chosen individual from the non-impaired group would have a test score higher than that of a randomly-selected individual from the cognitively-impaired group in 92.7% of cases.

As a complement to this, Table 5 shows the sensitivity and specificity values, the likelihood ratios and the predictive values for different cut-off points. It can be seen that as the

Table 5
Cut-off points, values of sensitivity and specificity, + LR and − LR, and positive and negative predictive values for SCIP subtests and total score.

Subtest	Criterion	Sensitivity	95% CI	Specificity	95% CI	+ LR	− LR	PPV	NPV
VLT-I	<19	0.643	0.547–0.731	0.818	0.751–0.874	3.54	0.44	0.706	0.771
	<20	0.723	0.631–0.804	0.764	0.691–0.826	3.06	0.36	0.675	0.803
	<21*	0.866	0.789–0.923	0.673	0.595–0.744	2.65	0.20	0.642	0.881
	<22	0.911	0.842–0.956	0.533	0.454–0.611	1.95	0.17	0.570	0.898
	<23	0.973	0.924–0.994	0.424	0.348–0.503	1.69	0.06	0.534	0.959
WMT	<18	0.654	0.556–0.744	0.750	0.677–0.813	2.62	0.46	0.625	0.773
	<19	0.710	0.615–0.794	0.625	0.547–0.698	1.89	0.46	0.547	0.772
	<20 *	0.832	0.747–0.897	0.512	0.434–0.590	1.70	0.33	0.520	0.827
	<21	0.888	0.812–0.941	0.423	0.347–0.501	1.54	0.27	0.495	0.855
	<22	0.935	0.870–0.973	0.280	0.213–0.354	1.30	0.23	0.452	0.870
VFT	<17	0.781	0.685–0.859	0.541	0.466–0.616	1.70	0.40	0.475	0.824
	<18	0.823	0.732–0.893	0.442	0.368–0.518	1.47	0.40	0.439	0.825
	<19 *	0.854	0.767–0.918	0.370	0.300–0.445	1.36	0.39	0.418	0.827
	<20	0.896	0.617–0.949	0.331	0.263–0.405	1.34	0.31	0.415	0.857
	<21	0.896	0.617–0.949	0.260	0.197–0.330	1.21	0.40	0.391	0.825
VLT-D	<5	0.549	0.457–0.639	0.813	0.742–0.871	2.94	0.55	0.698	0.696
	<6	0.721	0.633–0.799	0.639	0.558–0.714	2.00	0.44	0.661	0.744
	<7 *	0.852	0.777–0.910	0.510	0.428–0.591	1.74	0.29	0.578	0.814
	<8	0.959	0.907–0.987	0.303	0.232–0.382	1.38	0.14	0.520	0.904
	<9	0.984	0.942–0.998	0.116	0.070–0.177	1.11	0.14	0.467	0.900
PST	<10	0.636	0.557–0.710	0.946	0.886–0.980	11.76	0.39	0.945	0.640
	<11	0.765	0.693–0.828	0.775	0.686–0.849	3.40	0.30	0.832	0.694
	<12 *	0.889	0.830–0.933	0.622	0.525–0.712	2.35	0.18	0.774	0.793
	<13	0.981	0.947–0.996	0.468	0.373–0.566	1.85	0.04	0.729	0.945
	<14	1.000	0.977–1.000	0.333	0.247–0.429	1.50	0.00	0.686	1.000
Total SCIP	<68	0.836	0.756–0.898	0.845	0.778–0.898	5.40	0.19	0.802	0.873
	<69	0.853	0.776–0.912	0.826	0.757–0.882	4.90	0.18	0.796	0.883
	<70 *	0.879	0.806–0.932	0.806	0.735–0.865	4.54	0.15	0.773	0.899
	<71	0.888	0.816–0.939	0.761	0.686–0.826	3.72	0.15	0.736	0.901
	<72	0.914	0.847–0.958	0.723	0.645–0.791	3.29	0.12	0.711	0.918

cut-off point is moved in the direction of individuals without cognitive impairment, sensitivity increases but specificity decreases, while if it is moved in the direction of individuals with cognitive impairment the reverse is true. The optimal ROC operating points are marked with an * in Table 5.

Taking the PST subtest as an example, the cut-off point was set at 12, which yields a sensitivity of 0.89 and a specificity of 0.62. This means that, for this cut-off point, the PST score correctly classifies 89% of actual positive cases and 62% of actual negative cases. It can be seen that the +LR index has a value of 2.35, which indicates that the likelihood of obtaining a correct positive classification is more than double that of obtaining a false positive. On the other hand, the −LR of 0.18 indicates that the likelihood of a false negative is only 0.18-times the likelihood of obtaining a correct negative classification. Furthermore, the PPV of 0.774 indicates that, among individuals classified by the PST as having cognitive impairment, 77.4% do actually have it; similarly, the NPV of 0.793 signifies that 79.3% of individuals classified by the subtest as non-impaired do indeed have no cognitive impairment.

For the total SCIP score the cut-off point was set at 70, which yields a sensitivity of 0.88 and a specificity of 0.81. Here the +LR and −LR indices take values of 4.54 and 0.15, respectively, while the PPV is 0.773 and the NPV 0.899.

4. Discussion

The aim of administering the SCIP is to provide an initial objective approximation of an individual's cognitive ability and, in the event that certain deficits or diagnostic queries are detected, to pave the way for a more detailed assessment of the person's cognitive functioning. It should be remembered that screening tests must show high sensitivity and a high NPV in order to minimize the rate of false negatives, even if this leads to a certain increase in the number of false positives, in other words to a reduction in specificity. In order to confirm any cognitive impairment detected by the SCIP the individuals in question will subsequently undergo detailed assessment with another test (or set of tests), which must show a high specificity and PPV in order to minimize the rate of false positives.

The results of the present study as regards sensitivity and specificity indicate that the five subtests of the SCIP are able to differentiate between individuals with specific impairments and those who are cognitively intact. However, in light of the good results obtained for the test's total score it can be concluded that the SCIP gains clinical value by being interpreted globally, since other tools are available for exploring in detail the more specific aspects of cognition.

In this regard the global interpretation of the deficits identified by the SCIP is highly promising, since it correctly classifies cognitive impairment in approximately 88% of the individuals who also exhibited impairment on a traditional neuropsychological battery. Similarly, it adequately rejects 81% of those who are cognitively intact. As such, the SCIP could be regarded as a specific counterpart to the Mini Mental State Examination (MMSE; Folstein et al., 1975) for cognitive deficits in psychiatric patients.

Although there is no doubt that patients diagnosed with schizophrenia or bipolar disorder show cognitive impairment, along with certain specific positive or negative symptoms, these features are not found in all patients. A SCIP total score cut-off point of less than 70 detects the presence of cognitive impairment in 64.8% of patients with schizophrenia and 58.7% of those diagnosed with bipolar disorder. Studies of the prevalence of cognitive deficits have reported impairment in between 60 and 80% of patients with schizophrenia (Heinrichs and Zakzanis, 1998; Kéri and Janka, 2004; Weickert et al., 2000) and in between 30 and 60% of those diagnosed with bipolar disorder (Martino et al., 2009; Thompson et al., 2005). Therefore, it can be concluded that SCIP scores fall within the reported range for the prevalence of cognitive impairment in both the samples analyzed. The present results could also be considered in an inverse manner, in that the SCIP classifies as cognitively intact 84.8% of the control group. A finding that will deserve future analysis was the high +LR achieved by PST subtest. Even though the present study was aimed to examine the screening proprieties of SCIP to accurately detect cognitive impairment, it is widely acknowledged that likelihood ratios greater than 10 generate large and often conclusive changes from pretest to post-test probability (Jaeschke et al., 1994). This finding is in complete agreement with the results concerning the high value of Digit Symbol Coding Tasks for targeting a central feature of the cognitive deficit in schizophrenia (Dickinson et al., 2007), but also goes beyond to extend it towards bipolar disorder.

Another aspect which should not be forgotten when conducting a neuropsychological assessment is the practical utility of the tests administered, for if the aim is to diagnose a large number of psychiatric patients (who, it should be remembered, account for around 2% of the general population) this needs to be done with cheap and highly efficient tools. In this regard, previous studies have shown that the SCIP takes approximately 15 min to administer (Guilera et al., 2009; Pino et al., 2008), compared to a mean of around 75 min for the administration of a full neuropsychological battery. A further interesting feature of the SCIP, as with other tests designed for similar purposes, is that it is easy to administer and interpret and, as such, it can be adequately applied by personnel with minimal training while still ensuring a highly-sensitive initial screening of cognitively-impaired patients.

In addition, at a time when emphasis is being placed on the importance of including cognitive deficit as one of the diagnostic criteria for psychoses (Lewis, 2004; Keefe, 2008) it is increasingly necessary to apply statistical analyses that demonstrate the correct functioning of the tests used in diagnostic decision making.

In sum, the present study provides evidence for the adequate decision validity of the SCIP as a screening tool for cognitive impairment in patients diagnosed with schizophrenia or bipolar disorder. Obviously, the SCIP cannot replace the diagnostic value of a full neuropsychological examination, but it does offer a rapid and inexpensive mechanism for screening cases with a lower probability of significant impairments. Also, this instrument may be useful to assess the effectiveness of different treatments in clinical trials with respect to their impact on cognitive function.

One limitation of the present study concerns the battery chosen for use as the gold standard, and we are aware that it does not explore all the cognitive domains impaired in the functional psychoses (e.g., social cognition, and problem

solving). Future studies must therefore explore whether SCIP indicators can be related to other cognitive domains that are not directly assessed by the test.

Other aspects that require further investigation include demonstrating the utility of the instrument when applied by other health professionals (e.g., nurses, social workers, and occupational therapists) and determining the relationship between the data it yields and psychosocial and occupational performance. The brevity of the SCIP underscores its potential value to clinical trials aimed at improving cognitive skills which may be mitigating an improvement in functional outcome, although the sensitivity of the SCIP to pharmacotherapeutic interventions has yet to be confirmed. Finally, a matter of priority for the future is to establish norms for the SCIP according to the age and educational level of subjects.

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Contributors

Emilio Rojo, Oscar Pino, Georgina Guilera and Juana Gómez were responsible for analysis of data, interpretation of data and writing of manuscript. Eduard Vieta, Rafael Tabarés-Seisdedos, Nuria Segarra, Anabel Martínez-Arán, Manuel Franco, Manuel J. Cuesta, Benedicto Crespo-Facorro, Miguel Bernardo, and Scot E Purdon were responsible for interpretation of data and writing of manuscript. All authors approved the final manuscript. Francisco Mesa and Javier Rejas participated in the design of the study and supervision of CRO logistics and collection of data.

Conflict of interest

Javier Rejas and Francisco Mesa are employed by Pfizer Spain. All other authors declare that they have no conflicts of interest.

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Appendix A

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