Psychiatr. Pol. 2018; 52(2): 241–250
PL ISSN 0033-2674 (PRINT), ISSN 2391-5854 (ONLINE)
www.psychiatriapolska.pl
DOI: https://doi.org/10.12740/PP/OnlineFirst/69101

The Cognitive Screening Scale for Schizophrenia (CSSS) – Part 2: Validity of the scale

Anna Mosiołek[1], Jacek Gierus[1], Tytus Koweszko[1], Ada Nowakowska[2], Agata Szulc[1]

[1] Department of Psychiatry, Faculty of Health Sciences, Medical University of Warsaw
[2] J. Mazurkiewicz Mazovian Specialized Health Centre in Pruszkow

Summary

Aim. The present study is focused on further validation procedure of the CSSS – short screening scale designed for fast detection of persons with cognitive impairment and coexisting psychosocial disorders that demand deeper neuropsychological diagnosis and rehabilitation.

Material and methods. 67 subjects with schizophrenia and 36 healthy controls were examined with the CSSS, BACS, PANSS, and the Global Assessment of Functioning (GAF). Relationships between the CSSS score, age and education were tested with simple linear regression in groups of 124 subjects with schizophrenia and 36 healthy controls.

Results. Numerous statistically significant ($p < 0.05$) relationships between the CSSS and the BACS subtests, and the CSSS and the PANSS subscales were observed. The corrected CSSS score differs GAF ≤ 70 group from GAF >70 group.

Conclusions. The CSSS is a short method with satisfactory validity, that is adequate to the assumed goals and might be promising with respect to further development.

Key words: schizophrenia, cognitive impairment, screening scale

Introduction

The previously published first part of this paper presented the issues related to the design procedure and the factor structure of the CSSS. The results suggested a single-factor structure of the scale, and the factor measured by the scale explained 37% of the variance of results. The overall score of 16 raw points with satisfactory sensitivity (86%) and specificity (70%) differentiated people with schizophrenia from the control group. The individual sub-tests showed little differentiating power, which is in line with the assumptions of the method. The internal consistency of the method was satisfactory (0.83) [1]. There are still questions to be answered about the criterion

and construct validity of the method and the ways of minimizing factors potentially reducing it. The use of age and/or education corrections is a widely used solution in neuropsychological screening methods, including those which are most commonly used [2, 3], and in test batteries designed with people with schizophrenia in mind [4]. Their use should improve the validity, sensitivity and specificity of the method.

Aim

The aim of this paper is to examine the criterion and construct validity of the CSSS, and look at the impact of interfering variables on results, and make appropriate corrections.

Material and method

Study groups

A group of inpatients with schizophrenia ($N = 67$) treated at the J. Mazurkiewicz Mazovian Specialized Health Centre in Pruszkow was examined to determine the convergent validity of the scale. The CSSS and the Polish version of the Brief Assessment of Cognition in Schizophrenia (BACS) battery were used. 49% of the study group were women and 51% were men. The mean age in the study group was $M = 35.8$ years ($SD = 12.47$), and the average number of years of formal education $M = 13.97$ ($SD = 2.51$). Data from the control group ($N = 36$) was also used. In the control group ($N = 36$), the percentage of men and women was 40% and 60%, respectively. The mean age in the control group was 34.2 years ($SD = 14.36$).

Diagnostic methods

The Brief Assessment of Cognition in Schizophrenia (BACS) is a tool designed to measure cognitive functions in patients with schizophrenia. It consists of 6 subtests and takes less than 35 minutes to complete; based on their results, the overall score can be calculated. The Verbal Memory subtest involves repetition of a list of words 5 times, as in the popular RAVLT. The sum of the number of words repeated in all trials is assessed. In the Digit Sequencing subtest, the participant is presented with sequences of digits of increasing length to be remembered and then repeated in ascending order. The number of correctly repeated sequences is assessed. In the next subtest, the participant is asked to place 2 tokens into a container with both hands as quickly as possible. The number of tokens correctly placed in 1 minute is assessed. The Verbal Fluency subtest is assessed on the basis of the total number of words named in the categories: animal names, words that begin with the letter F and the letter S. The participant has 1 minute to complete each category. The Symbol Coding subtest is inspired by Digit Symbol-Coding from the Wechsler Adult Intelligence Scale-Revised (WAIS-R) [5]. The participant has 1.5 minutes to perform coding, and the number of correctly coded symbols in this time is assessed. The last subtest is the Tower of London subtest.

The participant is asked to imaginarily carry out a combination of moves using colored balls to obtain the desired sequence. Each task has a 20-second time limit. The number of correct answers is scored. The overall score takes into account the overall cognitive ability and the number of functions to be deteriorated. The standardized results of the scale are expressed in *z*-scores and *T*-scores. The BACS battery is sold in the Polish version along with a spreadsheet relating a test result to gender and age norms. The battery is characterized by satisfactory psychometric properties [4, 6, 7], and its overall result is significantly correlated with functioning in real life [7].

The Positive and Negative Syndrome Scale (PANSS) is a medical scale used for measuring the severity of positive and negative symptoms of schizophrenia and additional functioning disorders. Its reliability is highly dependent on the standardization of the study, and standardization – mainly on thorough training of the diagnostician. It takes 40–50 minutes to complete. Apart from results describing the intensification of positive and negative symptoms and general psychopathology, the PANSS also has an overall score. In this study, the Polish research version of the scale was used [8].

The Global Assessment of Functioning (GAF) scale is a numeric rating scale used by mental health professionals to assess the social, professional and psychological functioning of patients. The score is to reflect the symptomatic and functional problems in everyday life. The scale score ranges from 1 (severely impaired) to 100 (extremely high functioning) [9].

Testing procedure

The tests were conducted individually by trained psychologists working in one of the wards of the Department. The training included conducting the scale, assessment criteria, as well as the manner and conditions of running the tests (psychologist's office, silence, patient in euthymia). BACS training included reading instructions and watching training videos about conducting the battery and assessing results. Nosological diagnoses of schizophrenia were made or confirmed on the basis of history taking, psychiatric observations and psychological test methods by the staff of the Department, based on the criteria of ICD-10. Supervision of the diagnosis was performed by the head of the Ward. The head of the Ward also assessed the functioning of patients according to the GAF and PANSS. During the tests he did not have access to the results of the assessment of cognitive functions in order to avoid the Rosenthal Effect. The Bioethical Commission of the Medical University of Warsaw was informed about the study and did not make any objections with respect to the method or study material.

Statistical analyses

The following software was used to analyze the data: StatSoft STATISTICA 12 and PASW Statistics 18. A descriptive statistics analysis, a correlation analysis, a linear regression analysis and a ROC curve analysis were performed.

Results

Correlations between the CSSS scores and the BACS battery and the GAF and PANSS scores

A correlation analysis of the CSSS scores and the BACS battery scale scores was performed (the index was the standard scale scores which can be used to present the location of the raw score in relation to the standard deviation in the standardization group). Since the CSSS subscales are expressed on an ordinal scale, the Spearman's rho correlation coefficient was used. Table 1 shows the strongest correlations of the individual CSSS subtests with the BACS battery and PANSS subscales.

Table 1. **The strongest correlations of the CSSS subtests with the BACS and PANSS subscales**

CSSS Subscale	BACS and PANSS – Significant correlations ($p < 0.05$)
Planning and Switching	BACS Tower of London (rho = 0.42), PANSS Blunted Affect (rho = – 0.41), PANSS Poor Rapport (rho = – 0.35), PANSS Social Withdrawal (rho = – 0.26), PANSS Difficulty in Abstract Thinking (rho = – 0.36), PANSS Stereotyped Thinking (rho = – 0.24), PANSS Active Social Avoidance (rho = – 0.32)
Linguistic Learning	BACS Verbal Memory (rho = 0.45), PANSS Hallucinations (rho = – 0.26), PANSS Hostility (rho = 0.23), PANSS Motor Retardation (rho = – 0.24), PANSS Active Social Avoidance (rho = – 0.29)
Attention	BACS Tower of London (rho = 0.37)
Inhibitory Control	BACS Symbol Coding (rho = 0.38), PANSS Hallucinations (rho = – 0.24), PANSS Emotional Withdrawal (rho = – 0.29), PANSS Social Withdrawal (rho = – 0.27), PANSS Active Social Avoidance (rho = – 0.37)
Mechanical Memory	BACS Symbol Coding (rho = 0.46), PANSS Blunted Affect (rho = – 0.31), PANSS Poor Rapport (rho = – 0.28)
Reasoning through Analogy	BACS Symbol Coding (rho = 0.43), PANSS Disorganization (rho = – 0.28), PANSS Grandiosity (rho = – 0.29), PANSS Suspiciousness (rho = – 0.24), PANSS Blunted Affect (rho = – 0.25), PANSS Difficulty in Abstract Thinking (rho = – 0.31), PANSS Stereotyped Thinking (rho = – 0.28)
Creating General Concepts	BACS Verbal Fluency (rho = 0.50), PANSS Delusions (rho = 0.24), PANSS Grandiosity (rho = 0.26), PANSS Lack of Spontaneity and Flow of Conversation (rho = – 0.25), PANSS Motor Retardation (rho = – 0.25)
Abstract Reasoning	BACS Verbal Fluency (rho = 0.55) and BACS Symbol Coding (rho = 0.56), PANSS Disorganization (rho = – 0.23), PANSS Grandiosity (rho = – 0.23), PANSS Poor Rapport (rho = – 0.32), PANSS Difficulty in Abstract Thinking (rho = – 0.25), PANSS Lack of Spontaneity and Flow of Conversation (rho = – 0.30), PANSS Stereotyped Thinking (rho = – 0.30), Active Social Avoidance (rho = – 0.28)
Visual-constructive Functions	BACS Verbal Memory (rho = 0.25)

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Verbal Fluency	BACS Verbal Fluency (rho = 0.56), PANSS Poor Rapport (rho = – 0.30), PANSS Difficulty in Abstract Thinking (rho = – 0.24), PANSS Lack of Spontaneity and Flow of Conversation (rho = – 0.24), PANSS Motor Retardation (rho = – 0.27), Active Social Avoidance (rho = – 0.26)
Memory-Recall from Memory	BACS Overall Score (rho = 0.46), BACS Symbol Coding (rho = 0.43), PANSS Hallucinations (rho = – 0.31), PANSS Excitement (rho = 0.31), PANSS Poor Rapport (rho = – 0.26), PANSS Motor Retardation (rho = – 0.32), Active Social Avoidance (rho = – 0.29)
CSSS Overall Score	BACS Symbol Coding (rho = 0.60), BACS Overall Score (rho = 0.53), PANSS Blunted Affect (rho = – 0.32), PANSS Emotional Withdrawal (rho = – 0.32), PANSS Poor Rapport (rho = – 0.26), PANSS Social Avoidance (rho = – 0.25), PANSS Difficulty in Abstract Thinking (rho = – 0.25), PANSS Motor Retardation (rho = – 0.28), Active Social Avoidance (rho = – 0.40)

The relationship between the CSSS Overall Score and the GAF scale score was rho = 0.47, and the BACS Overall Score was correlated with the GAF of rho = 0.44. At the same time, however, significant correlations of the CSSS Overall Score and age and years of formal education were observed (rho = – 0.66 and rho = 0.28, respectively), and the relationship between the GAF scale and age was also significant (rho = – 0.46). For this reason, an attempt was made to eliminate the impact of age and education variables through age and education corrections.

The linearity of the relationship between the CSSS score and age and education – towards corrections

Linear regression analyses performed using the least squares method and scatter plots suggested the existence of a linear relationship between the CSSS Overall Score and age, and between the CSSS Overall Score and years of formal education, both in the clinical and control groups.

Having deleted outliers, simple regression analyses were performed separately for age and education. An analysis aimed at making corrections was performed for age corrections in the combined clinical and control groups, and for education corrections – in the control group (to avoid test bias due to reduced opportunities to get education in the clinical group). With regard to the relationship between age and the CSSS Overall Score, the regression equation was obtained CSSS = 19 + (-0.18) * Age [$R^2 = 0.20$; $SS_{Model} = 828.00$; $MS_{Residual} = 22.11$; $p = 0.01$] and with regard to the relationship between the CSSS Overall Score and years of formal education CSSS = 7 + 0.53 * years of education [$R^2 = 0.17$; $SS_{Model} = 75.08$; $MS_{Residual} = 10.81$; $p < 0.001$]. In connection with the obtained data, the following formula was constructed for Age and Years of Formal Education corrections:

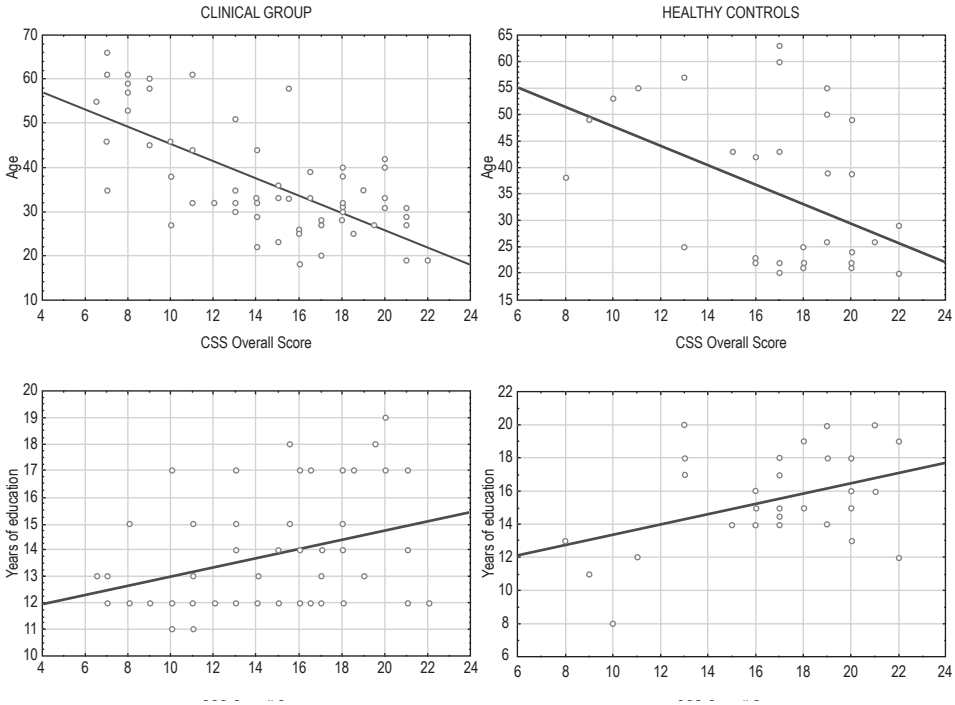

Figure 1. **Scatter plots of the relationship between the CSSS Overall Score and Age and the CSSS Overall Score and Education in the clinical and control groups**

Source: Author's own work. Statsoft STATISTICA 12 software.

$$CSSS_{corrected} = CSSS_{raw} + 0.18 * (Age - 19) - 0.53 * (years\ of\ education - 7)$$

Interpretation of the corrected score obtained in this way would, therefore, mainly refer to residuals, namely deviations of individual results from the normal values determined by regression equations. This form of a regression equation suggests that every 5 years of life after the age of 19 is associated with a 1-point decrease in the CSSS score. Every 2 years of formal education got after the first 7 years of education increase the CSSS score by 1 point. The above formula is aimed at correcting the score taking into account the values of the described systematic tendencies.

The essence of the use of the corrected result in the CSSS is its potential power differentiating people with difficulties in general functioning from those without such difficulties. As a criterion for distinguishing between the two groups, the GAF scale = 70 points was taken. The group with observable difficulties in functioning were people assessed by a psychiatrist as GAF ≤ 70; and for people with scores higher than 70 points in the GAF scale, it was assumed that their psychosocial difficulties are not visible to the environment. It was assumed that the CSSS corrected score is an inhibitor in detecting the GAF ≤ 70 group, and an analysis of the ROC curve was performed.

The cut-off point $CSSS_{corrected}$ = 18 points in the clinical group (N = 67) was characterized by 96% sensitivity and 75% specificity. Accuracy was Acc = 0.91. Comparative analyses performed for the BACS battery overall score showed that the point with the best sensitivity and specificity parameters showed 84% sensitivity and 75% specificity. So accurate scores of the CSSS can raise doubts as to reliability. To check how the corrected score differentiates people with schizophrenia from healthy people, data for 124 people with schizophrenia and 36 healthy people was examined. The score of 15 corrected points showed 73% sensitivity and 53% specificity. However, in this database the GAF was not assessed, and assignment to the group was only a diagnosis of schizophrenia *versus* no psychiatric diagnosis. In a situation where the purpose of the method is to find people who simultaneously experience cognitive impairment and a decline in functioning in order to redirect them to more accurate diagnostics, specificity is not a strictly desirable feature, because people who ultimately should not draw attention with the need to rehabilitate, should be excluded at the second stage.

The last problem to be solved in the context of the design of the CSSS is the impracticality of the formula for age and education corrections. Because the scale is intended to be short in use, it is difficult to expect a diagnostician to convert corrections in the presence of a patient. They should be attainable within a few seconds. Thus, it was decided to design a table of corrections which are read at the intersection of the age of the patient and the number of years of formal education. The correction table is shown in Table 2.

Table 2. **Corrections of the overall score depending on age and years of formal education**

CSSS CORRECTIONS		YEARS OF FORMAL EDUCATION										
		8	9	10	11	12	13	14	15	16	17	18
AGE	19	-1	-1	-2	-2	-3						
	20	0	-1	-1	-2	-2	-3					
	21	0	-1	-1	-2	-2	-3	-3				
	22	0	-1	-1	-2	-2	-3	-3	-4			
	23	0	0	-1	-1	-2	-2	-3	-4	-4		
	24	0	0	-1	-1	-2	-2	-3	-3	-4	-4	
	25	1	0	-1	-1	-2	-2	-3	-3	-4	-4	-5
	26	1	0	0	-1	-1	-2	-2	-3	-4	-4	-5
	27	1	0	0	-1	-1	-2	-2	-3	-3	-4	-4
	28	1	1	0	-1	-1	-2	-2	-3	-3	-4	-4
	29	1	1	0	0	-1	-1	-2	-2	-3	-4	-4
	30	1	1	0	0	-1	-1	-2	-2	-3	-3	-4
	31	2	1	1	0	0	-1	-2	-2	-3	-3	-4
	32	2	1	1	0	0	-1	-1	-2	-2	-3	-3
	33	2	1	1	0	0	-1	-1	-2	-2	-3	-3

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AGE	34	2	2	1	1	0	0	-1	-2	-2	-3	-3
	35	2	2	1	1	0	0	-1	-1	-2	-2	-3
	36	3	2	1	1	0	0	-1	-1	-2	-2	-3
	37	3	2	2	1	1	0	0	-1	-2	-2	-3
	38	3	2	2	1	1	0	0	-1	-1	-2	-2
	39	3	3	2	1	1	0	0	-1	-1	-2	-2
	40	3	3	2	2	1	1	0	0	-1	-2	-2
	41	3	3	2	2	1	1	0	0	-1	-1	-2
	42	4	3	3	2	1	1	0	0	-1	-1	-2
	43	4	3	3	2	2	1	1	0	0	-1	-2
	44	4	3	3	2	2	1	1	0	0	-1	-1
	45	4	4	3	3	2	2	1	0	0	-1	-1
	46	4	4	3	3	2	2	1	1	0	0	-1
	47	5	4	3	3	2	2	1	1	0	0	-1
	48	5	4	4	3	3	2	2	1	0	0	-1
	49	5	4	4	3	3	2	2	1	1	0	0
	50	5	5	4	3	3	2	2	1	1	0	0
	51	5	5	4	4	3	3	2	2	1	0	0
	52	5	5	4	4	3	3	2	2	1	1	0
	53	6	5	5	4	3	3	2	2	1	1	0
	54	6	5	5	4	4	3	3	2	2	1	0
	55	6	5	5	4	4	3	3	2	2	1	1
	56	6	6	5	5	4	3	3	2	2	1	1
	57	6	6	5	5	4	4	3	3	2	2	1
	58	6	6	5	5	4	4	3	3	2	2	1
	59	7	6	6	5	5	4	3	3	2	2	1
	60	7	6	6	5	5	4	4	3	3	2	2

Discussion and conclusions

The research presented in this paper leads to several conclusions relating to the diagnostic value of the CSSS.

First, both the scores of the CSSS subscale and the overall score of the scale significantly correlated with the subscales and the overall score of the BACS battery. The most correlated subscales of both methods measure similar processes. The CSSS overall score is strongly correlated with the overall score of the BACS battery, as well

as non-verbal learning processes and overall graphomotor skills. These abilities are similar to those needed in everyday life.

Second, the CSSS Scores show a significant correlation with the level of schizophrenia symptoms, measured by the PANNS. Especially many CSSS subtests negatively correlate with the scales of negative symptoms of schizophrenia and bradykinesia and active social avoidance. This knowledge is consistent with numerous studies confirming the association of cognitive disorders with negative symptoms and poor social rehabilitation [9].

Third, a linear relationship of the scale scores with age and the number of years of formal education was detected, which involved the need to make corrections based on the developed regression equations. A correction table was designed from which the number of points needed to correct the obtained result can be read quickly. The corrected overall score with 96% sensitivity and 75% specificity differentiated the groups with significantly reduced and relatively maintained general functioning, better than the BACS battery. When in another database, the schizophrenia–health criterion was taken as a criterion, without the GAF, these parameters were 73% and 53%. This data, due to the screening objective of the method, is satisfactory, if the corrected score of 18 points is taken as a cut-off point. It should be considered that people whose score was less than 18 points need enhanced neuropsychiatric diagnostics.

This study is not free from defects. The most important of these is the overrepresentation of hospitalized patients in the studied clinical trials. Further studies of the scale should be performed in a clinical trial consisting of at least 200 patients, of whom at least 100 are highly functioning outpatients.

In conclusion, the CSSS makes it possible to quickly select people with cognitive disorders and associated psychosocial disorders. A score below 18 corrected points should result in enhanced diagnostics, for example using the BACS battery and planning rehabilitation activities. The previous studies on the method suggest that it is characterized by satisfactory validity.

Acknowledgements. *We would like to thank Ewa Narkiewicz-Nejno, Paulina Małachowska, Agata Trzos and Anna Wiśniewska for their valuable help in conducting our research.*

Statement. *The authors report no conflict of interests.*

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Address: Jacek Gierus
Department of Psychiatry
Faculty of Health Sciences
Medical University of Warsaw
05-803 Pruszków, Partyzantów Street 2/4