D. Gil[1]
R. Bengochea[1]
M. Arrieta[1]
I. Lastra[2]
R. Sánchez[1]
A. Álvarez[1]
M. Diego[1]
R. Prat[1]

Use of Barcelona Test for cognitive assessment of patients with schizophrenia

[1] Centro de Rehabilitación Psicosocial Padre Menni
Santander
[2] Centro Hospitalario Padre Menni
Santander

Introduction. In recent years different neuropsychological batteries have been developed to assess cognitive performance in schizophrenia. However, no test has been validated in Spanish for this purpose. The Barcelona test has been one of the tests used. This present article has aimed to present a specific neurocognitive battery for schizophrenia by selecting specific subtests from the Barcelona Test. Normative data for patients with schizophrenia are presented and the influence of a number of variables is taken into account.

Methods. The sample included 209 patients. The relationship between cognitive performance and gender, age, educational level, age of onset, duration of illness and symptomatology were assessed. Symptomatology was collected with the Positive and Negative Syndrome Scale for Schizophrenia.

Results. More of the 50% of the sample had cognitive impairment when compared with standardized percentile scores of the Barcelona Test. No significant relationships between cognitive performance and variables assessed were found, except for in the educational level. Thus, percentile scores for the total sample and for the sample in terms of educational level were obtained.

Conclusions. The high percentage of patients with cognitive impairment when standardized percentile scores were used reinforces the need to use normative data appropriate for the schizophrenia group. The lack of relationship between cognitive performance and the variables assessed supports the hypothesis that cognitive impairment is a core feature in schizophrenia.

Key words:
Schizophrenia. Neuropsychological batteries. Cognitive impairment. Barcelona test.

Actas Esp Psiquiatr 2008;36(6):337-344

Uso del Test Barcelona para la valoración cognitiva de los pacientes con esquizofrenia

Introducción. En los últimos años se han desarrollado diversas baterías neuropsicológicas para valorar el rendimiento cognitivo en esquizofrenia. Sin embargo, no existe ningún instrumento validado en español que se utilice con este fin. Una de las pruebas utilizadas ha sido el Test Barcelona. El objetivo del presente artículo es presentar una batería neurocognitiva específica para esquizofrenia, mediante la selección de tests concretos del Test Barcelona. Asimismo se presentan baremos propios para los pacientes con esquizofrenia y se tiene en cuenta la influencia de una serie de variables.

Métodos. La muestra fue de 209 pacientes. Se valoró la relación entre el rendimiento cognitivo y las variables sexo, edad, nivel educacional, edad de inicio de la enfermedad, años de evolución y sintomatología. La sintomatología se recogió mediante la Escala del Síndrome Positivo y Negativo en la Esquizofrenia.

Resultados. En comparación con los baremos del Test Barcelona, más del 50% de la muestra presentaba deterioro cognitivo. No se encontraron relaciones significativas entre el rendimiento cognitivo y las variables analizadas, salvo para el nivel educacional. Por tanto se realizaron baremos para el total de la muestra y para la muestra en función del nivel educacional.

Conclusiones. El alto porcentaje de pacientes con deterioro cognitivo al utilizar baremos comparativos de población normalizada refuerza la conveniencia de utilizar baremos propios para el grupo de esquizofrenia. La falta de relación entre el rendimiento cognitivo y las variables analizadas apoya la idea de que el deterioro cognitivo es algo característico y estable en esquizofrenia.

Palabras clave:
Esquizofrenia. Baterías neuropsicológicas. Deterioro cognitivo. Test Barcelona.

INTRODUCTION

In the year 2002, the National Institute of Mental Health (NIMH) initiated what is called Measurement And Treat-

Correspondence:
David Gil
Centro de Rehabilitación Psicosocial Padre Menni
39004 Santander (Spain)
E-mail: crpsantpicol@mennisant.com

ment Research to Improve Cognition in Schizophrenia (MATRICS). The first step of the MATRICS project consisted in identifying the specific cognitive deterioration areas and characteristics of schizophrenia.

For this reason, a work group lead by Nuechterlein[1] reviewed a total of 13 studies that included a factorial analysis of cognitive performance in schizophrenia. The result of this review was the identification of six cognitive areas of deterioration: *a)* processing rate; *b)* attention and vigilance; *c)* working; verbal and visual memory; *d)* verbal learning; *e)* visual learning, and *f)* reasoning and problem solving (this cognitive area is also called executive functioning). These results confirmed the previous findings of other authors[2-4]. Later on, and in contrast with other professionals who formed a part of the MATRICS project, it was decided to include social cognition as the seventh cognitive function regarding schizophrenia[5,6].

Once the areas having the greatest deterioration were determined, the next step consisted in selecting the tests for the elaboration of a neuropsychological battery. This decision was adopted because there is no instrument that has been agreed on by consensus to evaluate cognitive performance in schizophrenia[7], and that serves to orient the interventions in rehabilitation and to evaluate the cognitive improvement derived from them[8]. A work group headed by Kern[7] was in charge of proposing a battery. This group elaborated the MATRICS Consensus Cognitive Battery (MCCB) (table 1). The battery, MCCB, evaluates six cognitive areas identified in this project and its application time is less than 60 min.

In the opinion of these authors, any instrument that is used to evaluate cognitive performance should fulfill a series of minimum requirements, standing out among them reliability, possibility of evaluating each cognitive area independently, existence of comparative scales, and test duration, proposing a time limit of one hour. In recent years, other neurocognitive batteries that fulfill these conditions and that stress the need to perform short evaluations that are easy-to-interpret have been developed. Table 1 offers a summary of some of these tests.

However, up to date, there are no known instruments that have been validated in Spanish for specific use in schizophrenia. One of the instruments used to evaluate cognitive deterioration is the Integrated Program of Neuropsychological Explanation Barcelona Test[9,10]. This test evaluates a wide group of cognitive functions and has a scale based on age and years of schooling. In a series of studies, Peña-Casanova[9,10] developed a short version of the test, with an approximate administration time of 30-45 min.

The present article uses the short version of the Barcelona Test to select the subtests that correspond with the cog-

Table 1 Tests used to evaluate cognitive performance in schizophrenia

Name of battery	Areas evaluated	Administration time	Format
Matrics Consensus Cognitive Battery (MCCB[29])	Processing rate, attention and vigilance, working, verbal and visual memory, reasoning and problem solving and social cognition. It offers a score of each area	60 min	Pencil and papel
Repeatable Battery for the Assessment of Neuropsychological Status (RBANS[30])	Attention, immediate memory, delayed memory, visual perception and language. It offers a total score	30 min	Pencil and papel
Brief Assessment of Cognition in Schizophrenia (BACS[8])	Verbal, working memory, motor speed, verbal fluency, attention and processing rate, and executive functions. It offers a total scale	30 min	Pencil and papel
Brief Cognitive Assessment (BCA[31])	Attention, verbal fluency and verbal learning	15 min	Pencil and papel
Cambridge Neuropsychological Test Automated Battery (CANTAB[32])	Visual memory, attention and executive functions	Variable, isolated test can be selected	Computer
MicroCog[33]	Attention, memory, reasoning, visual perception and reaction time	50-60 min	Computer
Computerized Neurocognitive Scanning[34,35]	Attention, memory, sensory-motor functions and executive functions	60 min	Computer

nitive areas reviewed by the MATRICS project, with the objective of presenting a specific neuropsychological battery for schizophrenia. Thus, tests were included that evaluate attention, processing speed, working, visual and verbal memory, verbal learning, visual learning, non-verbal reasoning and executive functioning. Table 2 includes the subtests that correspond with the cognitive variables selected.

Therefore, we have aimed to make a selection that would comply with the criteria proposed by Kern et al.[7]; that is, to obtain a battery with good reliability, that would evaluate each cognitive area independently and whose administration time would be short. Regarding the comparative scales, the MATRICS work group considered that it is more useful to compare the performance of a patient with schizophrenia with a normalized population group. However, in the opinion of Wilk et al.[11], cognitive deterioration in comparison with normalized scales is an expected result in schizophrenia. That is why these authors have stated that this comparison does not provide useful information and it is more important to determine the grade of affectation of a patient based on the expectations associated to the diagnosis of schizophrenia. Thus, it would be better to make scales that are appropriate to the group of patients with schizophrenia.

The above idea is supported by our own clinical observation that the comparison of the scores of schizophrenia patients with the normalized population scales of the Barcelona Test produces a floor effect that does not adequately collect the improvement achieved in the subtests applied. Based on this, this present article has aimed to elaborate scales appropriate for schizophrenia in order to compare the performance and subsequent evolution of a patient with his or her own normative group.

The influence of a series of variables on cognitive performance was also studied in order to make scales that took that variable into account if a significant relationship was obtained.

METHODS

The subtests selected were applied to a sample of 209 patients, all of whom had been diagnosed of schizophrenia according to ICD-10 criteria and were taking antipsychotic medication at the time of evaluation. All the patients were participating in the rehabilitation program in a Psychosocial Rehabilitation Center belonging to the Hospital Center Padre Menni of Santander. The characteristics of the sample are specified in table 3.

The relationship between cognitive performance and the following variables was evaluated: gender, age of patients,

Table 2 Selection of tests of the Barcelona Test

Subtests of the Barcelona Test
Direct digits
Inverse digits
Categorial evocation: words beginning with «P»
Memory of tests: immediate and delayed
Learning of words
Immediate visual memory
Delayed visual memory
Understanding
Numbers key
Cubes
Cognitive function evaluated
Attention
Working memory
Executive functioning
Verbal memory
Verbal learning
Visual memory
Visual learning
Capacity of abstraction
Processing speed
Non-verbal reasoning

Table 3 Characteristics of the sample

Characteristics	n = 209	Percentage
Gender		
Male	131	62.68
Female	78	37.32
Age		
18-29	82	39.23
30-39	86	41.15
40-49	41	19.62
Level of studies		
Incomplete	34	16.27
Primary	88	42.10
Secondary/upper	87	41.63
Years of evolution		
< 5	49	23.45
5-10	67	32.05
> 10	89	42.58
Unknown	4	1.92
Onset age		
< 25	147	70.33
≥ 25	58	27.75
Unknown	4	1.92

Table 4 Percentile scores of the total of the sample (n = 209)

Barcelona substest	Percentile scores										Percentile 30 of the Barcelona Test
	10	20	30	40	50	60	70	80	90	95	
Direct digits	4	5	5	5	6	6	7	7	8	8	6
Inverse digits	3	3	3	4	4	4	5	5	6	6	5
Words with P	13	18	23	24	26	27	30	32	37	45.5	32
Memory of texts	5.5	7.5	9	10.5	11.2	13	14	15	16	17	14
Memory with questions	9	12	13	14	15	16	17	18	19	20.3	17.5
Delayed memory	4	6.5	9	10	11	12	14	15	17	18	16
Delayed memory questions	7	10	12	13	14	15	16	18	19	20	18
Verbal learning	53	63	70	74	75	80	85	89	93	95	85
Visual memory	5	6	7	7	7.2	8	8	9	10	10	8
Delayed visual memory	4	7	9	9	9.6	11	12	13	15	16	13
Understanding	2	4	5	6	8	8	10	10	11	12	10
Numbers key	13	17	20	23	24.3	26	29	31	37	39	39
Cubes	2	3	4	4	4.3	5	6	6	6	6	5
Cubes time	5	7	9	10	10.5	11	13	15	17	17	15

educational level, age of disease onset, years of evolution and symptoms. The Positive and Negative Syndrome Scale (PANSS) in Schizophrenia, in the Spanish version of Peralta and Cuesta[12], was used to evaluate symptoms.

Statistical analyses

It was decided to extract the same percentiles that this test has in order to facilitate comparison with the normative data of the Barcelona Test. The percentile scores were obtained using the descriptive statistics frequency option in the SPSS, version 9.0 statistical program.

The difference of means test (*t* test) was used to find the relationship between cognitive performance and the variables of gender, age of disease onset and symptoms. The variable age of onset was dichotomized into before 25 years and with 25 years or more. Equally, the scores on each one of the symptoms of the PANSS scale were recoded into absence and presence of the symptom, using scores 1 and 2 (absent or doubtful symptom) as absence and the scores from 3 to 7 (presence of mild to extreme symptom) as presence.

The relationship between the rest of the variables (age of the patients, educational level and years of evolution) and the scores on the Barcelona Test subtests was analyzed with the ANOVA test (coding of the variables is shown in table 3).

Internal consistency of the test was also found with Cronbach's Alpha.

RESULTS

The scales for the entire sample are shown in table 4. This table also reflects the score corresponding to percentile 30 on the normalized population scale of the Barcelona Test. In this test, percentile 30 serves are cut-off indicative of cognitive deterioration. Table 5 shows the percentage of pa-

Table 5 Percentage of patients with deterioration using percentile 30 of the normalized scales of the Barcelona Test

Barcelona subtests	Score of percentile 30	Patients (%)
Direct digits	6	44.5
Inverse digits	5	68.7
Words with P	32	77.3
Memory of texts	14	65.9
Memory with questions	17.5	74.9
Delayed memory	16	82.5
Delayed memory questions	18	78.2
Verbal learning	85	66.8
Visual memory	8	52.1
Delayed visual memory	13	76.8
Understanding	10	67.3
Numbers key	39	93.8
Cubes	5	54
Cubes time	15	78.2

tients who are below this percentile in each one of the tests applied.

No significant differences were found in the general cognitive performance of the patients based on the sociodemographic variables of gender and age. In the case of gender, differences were only found in the subtests of visual memory (t: –2.840; p = 0.005) and cubes (t: –2.874; p = 0.004. In both cases, the mean score of men was greater than that of the women. In relationship to age, the number key (F: 3.151; p = 0.045) and new cubes (F: 6.6261; p = 0.002) tests were the only ones that had a differentiated performance.

Educational level was related with most of the cognitive functions evaluated. The results are shown in table 6. Utilization of the Bonferroni's post-hoc test for multiple comparisons showed that the differences principally occurred among patients with studies superior to primary education and the other two groups: incomplete schooling and primary studies. No significant differences were found between these two groups in any of the Barcelona Test subtests.

In regards to the clinical variables, no significant relationships were found between any of the variables evaluated and general cognitive performance. Age of onset was not related with any of the subtests. Years of evolution were only related with the numbers key test (F = 3.406; p = 0.035) and cube test (F = 5.928; p = 0.003).

Regarding symptoms, only the symptoms of abstract though and attention deficit of the PANNS were related with any of the cognitive performance measurements. The results are shown in table 7.

Based on the results obtained, it was decided to elaborate specific scales that considered the education level in addition to the scales for the entire sample. Given that the groups of incomplete studies and primary education did not show significant differences, it was decided to join both groups and make scales only with two education levels: below secondary (incomplete and primary) and equal or above secondary (secondary or superior). These scales are presented in table 8.

The internal consistency coefficient of the test was 0.82 (Cronbach's Alpha).

CONCLUSIONS

As table 5 shows, when the normalized scales of the Barcelona Test were used, more than 50% of our study sample obtained scores equivalent to deterioration in all the subtests selected, with the exception of the direct digits test, where the percentage was 44.5%. In table 4, it can be observed that the percentile 30 score in the case of the normalized population corresponds to the percentile 70 and 80 in the schizophrenia population in most of the tests. Thus,

Table 6 Relationship between educational level and subtests of the Barcelona Test

Subtests	Educational leve		
	F	gl	p
Direct digits	1.108	2	0.332
Inverse digits	4.671	2	0.010
Words with P	5.508	2	0.005
Memory of test	7.525	2	0.001
Memory with questions	6.588	2	0.002
Delayed memory	8.981	2	0.000
Delayed memory questions	5.826	2	0.003
Verbal learning	6.765	2	0.001
Visual memory	5.349	2	0.005
Delayed visual memory	7.493	2	0.001
Understanding	10.959	2	0.000
Numbers key	3.207	2	0.043
Cubes	2.561	2	0.080
Cubes time	5.445	2	0.005

Table 7 Relationship between the subtests of the Barcelona Test and the items of abstract thinking and attention deficit of the PANSS scale

Subtests	Abstract thinking			Attention deficit		
	t	gl	p	t	gl	p
Direct digits	1,424	192	0,156	1,340	192	0,182
Inverse digits	2,880	192	0,004	0,173	192	0,863
Words with P	3,801	192	0,000	2,518	192	0,013
Memory of texts	5,228	192	0,000	3,039	192	0,003
Memory with questions	3,944	192	0,000	2,382	192	0,018
Delayed memory	4,250	192	0,000	2,583	192	0,011
Delayed memory questions	3,561	192	0,000	1,894	192	0,060
Verbal learning	3,323	192	0,001	3,381	192	0,001
Visual memory	1,175	192	0,242	0,022	192	0,982
Delayed visual memory	2,456	192	0,015	0,820	192	0,413
Understanding	5,292	192	0,000	4,315	192	0,000
Numbers key	2,769	192	0,006	1,703	192	0,090
Cubes	2,740	192	0,007	0,879	192	0,380
Cubes time	3,965	192	0,000	1,168	192	0,244

Table 8 Percentile scores based on level of education

Percentile	Direct digits	Inverse digits	Words with P	Memory of texts	Memory with questions	Delayed memory	Delayed memory questions	Verbal learning	Visual memory	Delayed visual memory	Under standing	Numbers key	Cubes	Cubes time
Level of educational: incomplete and primary (n = 122)														
95	8	6	37	16.3	19.3	17	19.3	94	10	15	10.5	37.3	6	17
90	7.6	5	35	15	18.3	16.3	18.8	91	10	14	10	34.6	6	16
80	7	5	31	14	17	14	17	87	9	12.1	10	29	6	14
70	6	4	27	12.9	15.9	12	15	81	8	11	8	26	6	12.8
60	6	4	26	11.2	15.5	10.7	14	75.4	7.2	9.7	7	24.6	5	10.7
50	6	4	24	10	14	10	13	72	7	9	6	24	4	10
40	5	3	23.6	8.3	13	8	12	68	7	9	5	21.6	4	9
30	5	3	19.2	7.5	12	7	10	63	6	7	4	18	3	7
20	5	3	16	6	10	5	8	56	5	5	3	14.8	2	5
10	4	2	11.4	5	7.5	2.5	6	44.8	4	1.4	1.9	10	2	3
Level of education: secondary (n = 87)														
Percentile	Direct digits	Inverse digits	Words with P	Memory of texts	Memory with questions	Delayed memory	Delayed memory questions	Verbal learning	Visual memory	Delayed visual memory	Under standing	Numbers key	Cubes	Cubes time
95	8.4	6.4	46.4	17	20.7	19	20.3	95	10	16	12	44.5	6	17.4
90	8	6	40.4	16.1	19	18	19.1	94	10	16	12	39	6	17
80	7	5.4	34.4	15.7	18.2	16.4	19	90	9	14	11	33	6	15.4
70	7	5	31	15	18	15	17	88	9	12	10	30	6	14
60	6	4	29	14	16.9	14	16	85	8.8	12	10	28	5.8	12
50	6	4	28	13	16	12.5	15	79	8	11	9	25	5	11
40	5.2	4	26	12	15	11.6	13.7	76	8	9.6	8	24.3	4.3	10.5
30	5	3.4	26	11	14.5	10.6	13	74.2	7	9	7	22	4	10
20	5	3	22.6	9.6	13	9	11.8	70.6	7	9	6	19	3	9
10	5	3	14.8	7	11.4	5.9	8.8	66	5.8	7	4	15	3	6.8

what is considered to be minimum performance in a subject not diagnosed of schizophrenia would be equivalent to high performance in the case of patients with schizophrenia. These results agree with previous studies that established that the performance of the patients on cognitive tests is at approximately 2 standard deviations below the mean of the normalized population[13,14].

In addition, these data support the observation of Wilk et al.[15] that cognitive deterioration can be expected when comparing a patient with schizophrenia with the normalized population and reinforces the convenience of using appropriate scales, as indicated in the introduction of the article.

Regarding the neuropsychological battery proposed, it can be concluded that all the criteria proposed by the MATRICS project are fulfilled since it has good reliability (evaluated partially by internal consistency) that evaluates each cognitive area separately, and its application time is approximately 30 min.

Of all the variables analyzed, the educational level was the only one that was shown to have a significant relationship with most of the cognitive functions evaluated, a result that had been found in previous studies[11].

The lack of association between cognitive performance and age variables, years of evolution and symptoms supports the idea that the deterioration in the cognitive functioning is something characteristic of schizophrenia, and it is manifested in a stable way during the disease and independently of the symptoms[16-19]. The items abstract thinking and attention deficit of the PANSS scale, which were the only ones that showed a relationship with the Barcelona Test subtests, are items that evaluate the rater-observed cognitive deterioration.

In regards to the influence of the variables of gender and age of onset on cognitive performance, the review of the bibliography manifests that there is no unanimous agreement in this regards. In agreement with previous studies[20-22], in our study, the males presented better performance in the visual memory and cube tests. However, this difference cannot be considered characteristic of schizophrenia since there are studies in normalized population that have found the same results[23,24]. Regarding age of onset, some authors have found a greater incidence of cognitive deficits in patients with an early onset age[25,26]. Specifically, it has been established that the greatest deterioration is produced if the onset of the disease is before 25 years of age[21,27,28]. However, coinciding with previous results[17], our data do not indicate significant differences based on onset age.

One limitation of the study could be the characteristics of the sample since it was performed in patients who had cognitive deterioration. However, the aim of this study was to obtain cognitive performance scales in patients with deterioration, who are precisely those who have the floor effect in comparison with the scales of the normalized population.

To verify that the proposed neuropsychological battery does not have the same problem regarding the floor effect, future research that would provide more data on the test reliability and on its utility to evaluate the improvement in the cognitive functioning of the patients would be necessary. Furthermore, the sample size needs to be increase and to include a greater number of patients over 50 years of age.

REFERENCES

1. Nuechterlein KH, Barch DM, Gold JM, Goldberg TE, Green MF, Heaton RK. Identification of separable cognitive factors in schizophrenia. Schizophr Res 2004;72:29-39.
2. Saykin AJ, Gur RC, Gur RE, Mozley D, Mozley L, Resnick SM, et al. Neuropsychological function in schizophrenia. Selective impairment in memory and learning. Arch Gen Psychiatry 1991; 48:618-24.
3. Blanchard JJ, Neale JM. The neuropsychological signature of schizophrenia: generalized or differential deficit? Am J Psychiatry 1994;151:40-8.
4. Soriano MP, Jiménez JF, Martínez R. Alteraciones cognitivas en la esquizofrenia: algo más que investigación básica. Cuadern Psiquiatr Comunit 2004;4:131-45.
5. Green MF, Olivier B, Crawley JN, Penn DL, Silverstein S. Social cognition in schizophrenia: recommendations from the Measurement and Treatment Research to Improve Cognition in Schizophrenia new approaches conference. Schizophr Bull 2005;31:882-7.
6. Sergi MJ, Rassovsky YR, Nuechterlein KH, Green MF. Social perception as a mediator of the influence of early visual processing on functional status in schizophrenia. Am J Psychiatry 2006; 163:448-54.
7. Kern RS, Green MF, Nuechterlein KH, Deng BH. NIMH-MATRICS survey on assessment of neurocognition in schizophrenia. Schizophr Res 2004;72:11-9.
8. Keefe RSE, Goldberg TE, Harvey PD, Gold JM, Poe MP, Coughenour L. The brief assessment of cognition in schizophrenia: reliability, sensitivity, and comparison with a standard neurocognitive battery. Schizophr Res 2004;68:283-97.
9. Peña-Casanova J. Test Barcelona. Manual. Barcelona: Masson, 1990.
10. Peña-Casanova J. Normalidad, semiología y patología neuropsicológicas. Barcelona: Masson, 1991.
11. Wilk CM, Gold JM, Humber K, Dickerson F, Fenton WS, Buchanan RW. Brief cognitive assessment in schizophrenia: normative data for repeatable battery for the assessment of neuropsychological status. Schizophr Res 2004;70:175-86.
12. Peralta V, Cuesta MJ. Validación de la escala de los síndromes positivo y negativo (PANSS) en una muestra de esquizofrénicos españoles. Actas Luso Esp Neurol Psiquiatr Cienc Afines 1994; 22:171-7.
13. Hobart MP, Goldberg R, Bartko JJ, Gold JM. Repeatable battery for the assessment of neuropsychological status as a screening test in schizophrenia, II: convergent/discriminant validity and diagnostic group comparisons. Am J Psychiatry 1999;156: 1951-7.
14. Wilk CM, Gold JM, Bartko JJ, Faith D, Fenton WS, Knable M, et al. Test-retest stability of the repeatable battery for the assessment of neuropsychological status in schizophrenia. Am J Psychiatry 2002;159:838-44.
15. Wilk CM, Gold JM, McMahon RP, Humber K, Iannone VN, Buchanan RV. No, it is not possible to be schizophrenic yet neuropsychologically normal. Neuropsychology 2005;19:516-22.
16. Bilder RM, Goldman RS, Robinson D, Reiter G, Bell L, Bates JA, et al. Neuropsychology of first-episode schizophrenia: initial characterization and clinical correlates. Am J Psychiatry 2000;157: 549-59.
17. Heaton RK, Gladsjo JA, Palmer BW, Kuck J, Marcotte TD, Jeste DV. Stability and course of neuropsychological deficits in schizophrenia. Arch Gen Psychiatry 2001;58:24-32.
18. Lewis R. Should cognitive deficit be a diagnostic criterion for schizophrenia? J Psychiatry Neurosci 2004;29:102-13.
19. Bowie CR, Harvey PD. Cognition in schizophrenia: impairments, determinants, and functional importance. Psychiatr Clin North Am 2005;28:613-33.
20. Perlick D, Mattis S, Stastny P, Teresi J. Gender differences in cognition in schizophrenia. Schizophr Res 1992;8:69-73.
21. Lewine R, Haden C, Caudle J, Shureff R. Sex-onset effects on neuropsychological function in schizophrenia. Schizophr Bull 1997;23:51-61.
22. González E, Alonso del Teso F, Mínguez L, Sanguino RM. Deterioro cognitivo, esquizofrenia y género. An Psiquiatr 2004;20: 356-60.
23. Halpern DF. Sex differences in cognitive abilities, 2.ª ed. Hillsdale: Erlbaum, 1992.
24. Leung A, Chue P. Sex differences in schizophrenia: a review of the literature. Acta Physiol Scand 2000;101:3-38.
25. Bellino S, Rocca P, Patria L, Marchiaro L, Raserri R, Di Lorenzo R, et al. Relationships of age at onset with clinical features and cognitive functions in a sample of schizophrenia patients. J Clin Psychiatry 2004;65:908-14.
26. Tuulio-Henriksson A, Partonen T, Suvisaari J, Haukka J, Lönnqvist J. Age at onset and cognitive functioning in schizophrenia. Br J Psychiatry 2004;185:215-9.

27. Hoff AL, Harris D, Faustman WO, Beal M, DeVilliers D, Mone RD, et al. A neuropsychological study of early onset schizophrenia. Schizophr Res 1996;20:21-8.
28. Poole JH, Ober BA, Shenaut GK, Vinogradov S. Independent frontal-system deficits in schizophrenia: cognitive, clinical, and adaptive implications. Psychiatry Res 1999;85:161-76.
29. Nuechterlein KH, Green MF. MATRICS Consensus Cognitive Battery. Los Ángeles: Matrics Assessment Inc., 2006.
30. Randolph C. RBANS manual: repeatable battery for the assessment of neuropsychological status. San Antonio: The Psychological Corporation, 1998.
31. Velligan DI, DiCocco M, Bow-Thomas C, Cadle C, Glahn DC, Miller AL, et al. A brief cognitive assessment for use with schizophrenia patients in community clinics. Schizophr Res 2004;71:273-83.
32. Sahakian BJ, Owen AM. Computerized assessment in neuropsychiatry using CANTAB: discussion paper. J R Soc Med 1992;85: 399-402.
33. Powell DH, Kaplan EF, Whitla D, Weintraub S, Catlin R, Funkenstein HH. Microcog: assessment of cognitive functioning (version 2.1) (Computerized software). San Antonio: The Psychological Corporation, 1993.
34. Gur RC, Ragland D, Moberg P, Turner TH, Bilker WB, Kohler C, et al. Computerized neurocognitive scanning: I. methodology and validations in healthy people. Neuropsychopharmacology 2001; 25:766-77.
35. Gur RC, Ragland D, Moberg P, Turner TH, Bilker WB, Kohler C, et al. Computerized neurocognitive scanning: II. The profile of schizophrenia. Neuropsychopharmacology 2001;25:777-88.