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Stability of performance on neuropsychological tests in patients with schizophrenia

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Abstract This study evaluated the stability of performance on neuropsychological tests in a group of 14 schizophrenic patients. These patients were first tested as inpatients and later on as outpatients. The patients' results are also compared with matched normal controls and with standardized norms. The patients' test results were stable over time and no change in performance was found for the patients as a group, suggesting that these aspects of the patients' functioning were of a trait quality. The patient group had significantly poorer results on a majority of the tests compared with the controls. The variation of the level of cognitive functioning among the patients, however, was great. In clinical practice today, neuropsychological examinations are often included in the diagnostic procedure, and their results also have impact on treatment planning. However, the possibility to generalize the findings is reduced as a consequence of the low number of patients in the study.

Key words Neuropsychology · Cognitive functioning · Schizophrenia

Introduction

Cognitive deficits in schizophrenic patients, compared to normal controls, have been shown in many studies (Levin et al. 1989, Frith et al. 1991, Hoff et al. 1992, Jeste et al. 1995). The interest in studying these aspects of functioning has increased and neuropsychological examinations of inpatient schizophrenic patients are today considered as an important part of the diagnostical procedure (American Psychiatric Association Practice Guidelines, 1997).

A debate has taken place whether these deficits are of a general kind or if they are of a more specific nature resulting in impairments in a reduced number of intellectual functions. Unfortunately, as Blanchard and Neale (1994) sum up: "the search for the neuropsychological signature of schizophrenia has yielded ambiguous or contradictory results". In their own study from 1994 they found a pattern of generalized neuropsychological impairment in a group of unmedicated patients.

A second question for debate has been whether the reduced intellectual capacity shown in the performance on neuropsychological tests truly is a function of stable neuropsychological dysfunction of psychobiological origin – or if the lower level of performance relates to situational factors changeable over time. Examples of these factors would be the degree of psychiatric symptomatology, the patient's motivation to the testings, influence of neuroleptic treatment and, in the long run, a progressive course of the illness resulting in further reduction of performance. The question of trait versus state perspective on this aspect of the schizophrenic disorder is an area suitable for further investigation. Saykin et al. (1994) compared a group of 37 patients with first episode schizophrenia who were never exposed to neuroleptics with 65 unmedicated, previously treated patients. The two groups had nearly identical test profiles showing generalized impairment. An additional conclusion was that verbal memory and learning may play a particular role, being primary neuropsychological deficits present early in the course of schizophrenia.

From a clinical point of view, results from neuropsychological examinations often have great impact on treatment goals and future planning for the patients. Studies of the functional consequences of cognitive deficits for the patients' daily lives were reviewed by Green (1996). He found that the most consistent finding was that verbal memory was associated with all types of functional outcome.

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The number of follow-up studies dealing with the question of the stability in test performances over time for the same individuals is, however, limited. Moreover, the results from such studies are contradictory. In a one-year follow-up study Sweeney et al. (1991) found significant improvement in neuropsychological functioning on several tasks. For many patients the performance at the follow-up was in line with normative scores from test standardization samples. The authors concluded that recovery of cognitive functioning can occur after clinical recovery from an acute episode of the illness. Nopoulos et al. (1994), on the other hand, found that cognitive function remained stable in most domains over one and two years in a group of patients with new or recently onset schizophrenia, suggesting that these deficits may be a trait of the illness.

The purpose of the present study was to further explore the issue of stability of performance on neuropsychological tests in a group of schizophrenic patients and to compare these patients' performances with a group of matched normal controls and with normative scores from a large test standardization sample.

Materials and methods

Subjects

All schizophrenic patients, who, during the last few years, had been neuropsychologically examined in connection with their inpatient treatment at St Göran's hospital in Stockholm, were contacted again and asked to participate in a repeated testing. These 21 patients had an unambiguous diagnosis of schizophrenia according to DSM-III-R (American Psychiatric Association, 1987), and they were contacted by the psychologist (K.E.) who had administrated the first testing. Seven of the patients did not want to participate. Thus, a group of 14 patients (8 females and 6 men) was possible to follow up.

The first testing (T1) had been carried out shortly before the patients' discharge from the ward, after clinical improvement from the acute episode of the illness. All patients had ongoing neuroleptic medication at the time of these testings. At the time of the repeated testing (T2) all patients were outpatients and three of them were now off neuroleptic medication. The repeated testings were carried out in an average of 17.6 months after the first testings (range 9–26) and by the same psychologist. No economic compensation was offered to the patients.

As the control group, 14 healthy volunteers were administrated the same test battery. These individuals were assessed free from psychiatric disturbances through an interview with a psychiatrist (U.Ö.). They were selected to approximately match the patient group at the first testing with respect to sex, age, and level of education and were given a minor economic compensation for their cooperation. No differences existed regarding sex, age or level of education between the two groups (Table 1).

Neuropsychological testing

The neuropsychological test battery used in this study was composed of a series of established tests, representing important aspects of cognitive functioning. Furthermore, all tests have normative scores from a large standardization sample (Bergman 1987). This fact makes it possible to express the patients's test performance in relation to the distribution of performance among a large (n = 400) randomly selected sample from the general Swedish population. These standard scores are expressed in age- and education-scaled non-normalized numeric T-scores (M = 50, SD = 10). Thus, the tests used in this study fulfilled the psychometric quality of standardization which can be demanded.

All test results, both for the patients and the controls, are expressed according to these norms in this study. A high T-score indicates superior performance.

The battery consisted of 13 tests. Three tests were tests of general intellectual ability, measuring *verbal understanding, logical reasoning* and *visuo-spatial ability* (the Synonyms Test, the Reasoning Test and the Block Design Test, respectively; Dureman and Sälde 1971). The performances on these tests were then combined to a total score of *general intellectual ability*. This set of tests has a long tradition of use in Swedish clinical practice.

Four tests from Halstead-Reitan's neuropsychological test battery (Reitan and Wolfson 1985) were included, namely tests measuring *abstract comprehension* (the Category Test), *scanning and flexibility* (the Trail Making Test, task A and B), *motor speed of dominant hand* and *nondominant hand* (the Finger Tapping Test), and *discrimination of rhythms* (the Seashore Rhythm Test).

To measure *verbal learning and retention* a test well known in Sweden was used (the Claeson-Dahl Verbal Learning Test and Retention Test; Claeson et al. 1971). Finally, a test of *visuo-spatial short-term memory* (the Memory for Designs Test; Graham and Kendall 1960) completed the battery.

Statistical analyses

The stability in test performance over time for the patients was analyzed by 1) the difference in T-scores for each test between T1 and T2 (Paired-Samples T test), 2) the correlation between T1 and T2 for each test (Pearson correlation coefficient), 3) the correlation between each patient's rank of his results on the 13 tests at T1 and T2, respectively (Spearman correlation coefficient), and 4) an interval of +–2 standard error (s_e) around each observed test score at T1 was calculated. This made it possible to determine, with a confidence of 95%, whether the individual's test score at T2 had truly changed. The proportion of test scores at T2 which were below (=

Table 1 Mean (SD) demographics of patient group, control group, and dropout patients

	Patients (n = 14; 8 females and 6 men)	Controls (n = 14; 9 females and 5 men)	Dropout patients (n = 7; 5 females and 2 men)
Age at first testing (years)	32.8 (4.6)	31.6 (6.2)	35.3 (5.8)
Level of education (years)	12.1 (2.2)	12.5 (1.6)	11.7 (1.8)
Age at debut of schizophrenia (years)	28.1 (4.9)		30.0 (7.1)
Duration of illness up to first testing (years)	4.6 (4.0)		5.3 (5.5)
Follow-up time (months)	17.6 (5.9)		
Number of patients on neuroleptic treatment:			
at first testing	14		
at repeated testing	11		

Table 2 The patients' T-scores at first testing (T1) and repeated testing (T2), $n = 14$

Test	T1 mean (SD)	T2 mean (SD)	Paired-Samples T Test *P*	Pearson correlation *r*	*P*
Synonyms Test (verbal understanding)	47.6 (10.5)	46.9 (11.3)	0.777	0.71	0.004
Reasoning Test (logical reasoning)	45.9 (9.0)	45.9 (11.3)	1.000	0.70	0.006
Block Design Test (visuo-spatial ability)	44.8 (12.3)	45.1 (12.7)	0.896	0.79	0.001
General intellectual ability	44.6 (11.9)	45.1 (14.3)	0.839	0.78	0.001
Category Test (abstract comprehension) *n* T1 = 12, *n* T2 = 12	45.6 (10.4)	50.0 (10.3)	0.285	0.65	0.032
Trail Making Test A (scanning)	43.7 (11.0)	45.1 (11.1)	0.585	0.63	0.016
Trail Making Test B (scanning and flexibility)	40.7 (14.5)	47.6 (10.3)	0.083	0.43	0.121
Finger Tapping Test, dominant hand (motor speed) *n* T1 = 11	40.8 (8.9)	44.8 (11.5)	0.609	0.47	0.143
Finger Tapping Test, nondominant hand *n* T1 = 11	41.4 (12.1)	45.7 (15.5)	0.541	0.71	0.015
Seashore Rhythm Test (discrimination of rhythms) *n* T1 = 13	47.3 (11.3)	46.9 (13.2)	0.921	0.63	0.020
Claeson-Dahl Verbal Learning Test	40.6 (10.5)	43.2 (8.8)	0.365	0.42	0.139
Claeson-Dahl Retention Test	42.6 (12.1)	45.4 (9.7)	0.240	0.70	0.005
Memory for Designs Test (visuo-spatial short-term memory)	39.4 (13.4)	36.8 (15.2)	0.481	0.58	0.031

Table 3 The number of patients' test scores at repeated testing (T2) which fall below, within, and above an interval of $\pm 2\ s_e$ from the test scores at first testing (T1), respectively

Test	below	within	above	*n*
Synonyms Test	3	8	3	14
Reasoning Test	2	11	1	14
Block Design Test	2	10	2	14
Category Test	0	9	2	11
Trail Making Test A	1	11	2	14
Trail Making Test B	1	10	3	14
Finger Tapping Test, dominant hand	2	7	2	11
Finger Tapping Test, nondominant hand	1	7	3	11
Seashore Rhythm Test	2	9	2	13
Claeson-Dahl Verbal Learning Test	1	9	4	14
Claeson-Dahl Retention Test	0	13	1	14
Memory for Designs Test	2	11	1	14
	17 10.8%	115 72.8%	26 16.5%	

deterioration) and above (= improvement) such an interval will be presented respectively.

The patient group's performances at T1 and T2 were compared to a matched normal control group (Independent-Samples T Test). The patients' performances, at both T1 and T2, were also compared to the normative scores. For all analyses a *P*-value of < 0.05 was chosen as a level for statistical significance.

Results

The analyses of stability

There were no significant differences in the patient group means between T1 and T2 across the tests (Table 2). Table 2 also shows that the correlations between T1 and T2 were significant for 10 of the 13 tests, the coefficients varying between 0.58 (Memory for Designs Test) and 0.79 (Block Design Test). The amount of explained variance thus varied between 34% and 62% among these tests. Only the Trail Making Test B, the Finger Tapping Test (dominant hand), and the Claeson-Dahl Verbal Learning Test showed non-significant associations (r = 0.43, 0.47, 0.42, respectively).

The test profiles at T1 and T2 showed a significant similarity to each other in 9 of the 14 patients (64%). The rank correlation coefficients varied between 0.84 and 0.59. The remaining 5 patients were less stable in their patterns of performance.

The 14 patients produced a total of 158 test scores at T2; 115 (72.8%) of these were within an interval of $+\text{–}2\ s_e$ from the test scores at T1 (Table 3). In these cases no certain change (with a confidence of 95%) in performance could be concluded. A certain change for the worse was noticed for 17 (10.8%) of the test scores, and a certain change for the better was noticed for 26 (16.5%). These certain changes were distributed among all the tests.

Table 4 T-scores at first testing (T1) and repeated testing (T2), respectively, for the patients, $n = 14$, and T-scores for the control group, $n = 14$, Independent-Samples T Test

Test	Patients T1			Controls		Patients T2		
	M	SD	*P*	M	SD	M	SD	*P*
Synonyms Test	47.6	10.5	0.285	52.1	11.6	46.9	11.3	0.240
Reasoning Test	45.9	9.0	0.001	57.1	7.0	45.9	11.3	0.004
Block Design Test	44.8	12.3	0.012	55.3	7.3	45.1	12.7	0.017
General intellectual ability	44.6	11.9	0.004	56.6	7.9	45.1	14.3	0.014
Category Test	45.6	10.4	0.003	56.5	6.3	50.0	10.3	0.060
Trail Making Test A	43.7	11.0	0.002	55.6	6.4	45.1	11.1	0.005
Trail Making Test B	40.7	14.5	0.001	55.6	5.0	47.6	10.3	0.014
Finger Tapping Test, dominant hand	40.8	8.9	0.061	47.8	8.6	44.8	11.5	0.442
Finger Tapping Test, nondominant hand	41.4	12.1	0.114	48.8	10.5	45.7	15.5	0.544
Seashore Rhythm Test	47.3	11.3	0.037	56.1	9.4	46.9	13.2	0.043
Claeson-Dahl Verbal Learning Test	40.6	10.5	0.002	53.1	9.1	43.2	8.8	0.007
Claeson-Dahl Retention Test	42.6	12.1	0.182	48.4	10.4	45.4	9.7	0.437
Memory for Designs Test	39.4	13.4	0.001	54.1	4.6	36.8	15.2	0.001

Table 5 Proportion of patients with lower T-scores than 1 and 2 SD (T-scores < 40 and T-scores < 30), respectively, from standard norm's mean (T-score 50) at first testing (T1) and repeated testing (T2). Corresponding figures for the control group are put in brackets

Test	T1					T2				
	n	< 40		< 30		*n*	< 40		< 30	
Synonyms Test	14	4 (3)	29% (21%)	1	7%	14	4	29%	1	7%
Reasoning Test	14	3	21%	0	0%	14	3	21%	1	7%
Block Design Test	14	5	36%	1	7%	14	6	43%	2	14%
General intellectual ability	14	5	36%	1	7%	14	4	29%	2	14%
Category Test	12	3	25%	1	8%	12	2	17%	1	8%
Trail Making Test A	14	4	29%	3	21%	14	4	29%	1	7%
Trail Making Test B	14	4	29%	2	14%	14	2	14%	1	7%
Finger Tapping Test, dominant hand	11	6 (2)	55% (14%)	0	0%	14	4	29%	1	7%
Finger Tapping Test, nondominant hand	11	5 (2)	46% (14%)	1	9%	14	5	36%	0	0%
Seashore Rhythm Test	13	2 (1)	15% (7%)	1	8%	14	4	29%	2	14%
Claeson-Dahl Verbal Learning Test	14	7 (1)	50% (7%)	2	14%	14	6	43%	1	7%
Claeson-Dahl Retention Test	14	5 (4)	36% (29%)	2	14%	14	4	29%	1	7%
Memory for Designs Test	14	6	43%	1	7%	14	7	50%	4	29%

Comparisons with the normal control group and with the standardized norms

The results of the patient group at T1 were significantly poorer for 9 tests in comparison with the control group (Table 4). No significant difference was found between the groups in the Synonyms Test, the Finger Tapping Test (both dominant and nondominant hand), and the Claeson-Dahl Retention Test. The same pattern was found for the patient group's results at T2, with the exception of the results from the Category Test. No significant difference between the groups was found on this test at T2.

The proportion of patients who, at T1 and T2 respectively, had lower test scores than 1 respectively 2 SD from the norm's mean (T-score 50) are presented in Table 5. Such test scores represent performances lower and much lower than normal, respectively. At T1 the proportion of patients with results lower than normal varied between 15% (Seashore Rhythm Test) and 55% (Finger Tapping Test, dominant hand) over the tests. The proportion of patients with results much lower than normal varied between 0% (Reasoning Test and Finger Tapping Test, dominant hand) and 21% (Trail Making Test A). At T2 the proportion of patients with results lower than normal varied between 14% (Trail Making Test B) and 50% (Memory for Designs Test). The proportion of patients with results much lower than normal varied between 0% (Finger Tapping Test, nondominant hand) and 29% (Memory for Designs Test).

Discussion

The purpose of the present study was to investigate the stability of performance on neuropsychological tests in a group of schizophrenic patients. Our conclusion is that the patients' test data in our study are stable and that this supports the view of trait quality regarding these aspects of functioning. The data show a robustness, and no change in performance has been found for the patients as a group. The imperfection in stability that still exists seems to be in the range of the imperfection present in all psychological

testings. Presumably, the instability does not differ to any higher degree from testings of normal populations. Our study also showed that the patients performed poorer than the normal controls and that there was a large variability in performance within the patient group.

The issue of stability may be discussed further. First, in none of the 13 tests were the patient group's means significantly different between the two test occasions. However, the low statistical power when examining such a small sample ($n = 14$) may give a misleading picture. It is possible that differences will be found in samples of greater size.

Second, the additional analyses performed in this study give further support for the validity of stability. Of 13 tests used, 10 showed significant correlations between T1 and T2. These coefficients varied between 0.58 and 0.79. Another approach is to compare these figures with the tests' test-retest coefficients from the test standardization study. These vary between 0.41 and 0.88. Only for three of the tests are there clear differences at hand between the test-retest coefficients and our sample's correlations. The test-retest coefficient for the Claeson-Dahl Verbal Learning Test is 0.85 and for the Trail Making Test B 0.75. In our sample the correlations are weaker, 0.42 respectively 0.43. On the other hand our sample's correlation for the Claeson-Dahl Retention Test is much stronger, 0.70; the test-retest coefficient is 0.41. To allow a quality of stability in our data, it does not seem reasonable to expect higher correlations than the tests themselves offer.

Furthermore, the issue of stability is not only a matter of level of performance, it is also important to evaluate intraindividual differences in the test profiles between test occasions. It has been found in our study that the test profiles for 64% of the patients were significant in rank of test scores between the two testings. A good proportion of the patients were thus stable in their patterns of performance.

Finally, the analysis of standard error showed that no certain change can be concluded in 72.8% of the testings at T2. In our view, there is probably no instability in our data that would deviate from a normal sample.

The second part of this study reveals that in comparison with the control group our patients performed poorer. The difference was significant for 9 of the total of 13 tests at T1 and for 10 at T2. On a group level, our data corresponds with the view that the dimension of neuropsychological functioning is affected among patients with a schizophrenic disorder (Frith et al. 1991, Hoff et al. 1992, Jeste et al. 1995). Additionally, our data showed most aspects of functioning to be affected, a result that corresponds to a general perspective rather than a specific perspective regarding these kinds of impairments (Blanchard and Neale 1994). The four tests in which no difference was found, neither at T1 nor T2, were the Synonyms Test, the Finger Tapping Test (both dominant and nondominant hand), and the Claeson-Dahl Retention Test. The results regarding motor speed will be of certain interest, when taking into consideration that most patients were on neuroleptics. Obviously, this fact does not seem to have had an effect on the patients' performances. The similar results on the Claeson-Dahl Retention Test may be an artefact. The T-scores express the amount of retention of learned words, but since the patients had poorer learning capacity than the normal controls it does not necessarily reflect an equal memory capacity in a broader sense. Furthermore, at T2 no difference existed in the Category Test. This may be a result of a learning effect. The test is also probably the test most sensitive to learning effects. The similar pattern of differences between patients at T1 and T2 compared to the controls is also an additional support of the stability in performance.

In comparison with the large normal material (the norm group), our controls had results that were somewhat above the standard mean (T-score 50) for the majority of the tests. The selected controls, therefore, represented a group of rather highly capable persons. However, they were matched to the patient group with respect to level of education. The patient group's performances, on the other hand, did not reach the norm's mean at any test, neither at T1 nor T2, except for in the Category Test at T2 (mean T-score 50.0). Again, probably a result of a learning effect. The group means of the patients are thus lower than the norm's means but they are not lower than 1 SD (T-scores < 40.0) except for in the Memory for Designs Test (T1 39.4, T2 36.8). This implies that the patient group in total cannot be said to have clear neuropsychological deficits, although they perform poorer than the controls. Their means are within a normal range, thus, not at a level which indicates great impairments. The variability in the patient group is large, however, and Table 5 shows the proportion of the patients in those cases where the results are outside a normal range. If the cut-off point was set at below 1 SD from the norm's mean, the proportions varied between 55% (Finger Tapping Test, dominant hand at T1) and 14% (Trail Making Test B at T2). At a cut-off point below 2 SD, results at a level indicating great impairments, the proportions varied between 29% (Memory for Designs Test at T2) and 0% (Reasoning Test, Finger Tapping Test dominant hand at T1 and Finger Tapping Test nondominant hand at T2). Thus, the cognitive dimension of functioning was affected to a variable degree among our patients, a fact showing the importance of careful evaluation of each individual case.

The number of patients in our study was, however, limited. This fact must be taken into account. With data from only 14 patients the conclusions must be interpreted with caution. There are also very limited possibilities to generalize the results. Therefore, the contribution of our study to the collected knowledge of the schizophrenic illness in general is only speculative. Our sample was a consecutive series of inpatients from the same catchment area. Unfortunately, 7 of the patients who had been examined in the first place did not want to participate in the study. However, this dropout group was not significantly different regarding the four demographic variables presented in Table 1. The low number of follow-up patients also means that no split of the sample is meaningful, although interesting analyses of subgroups or background variables are not

hard to find, e.g., type of schizophrenia (Cuesta and Peralta 1995).

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