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Disturbances of cognitive processes in patients with schizophrenic psychoses. Part 1. Attention disorders

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Test of the ability to focus attention on the task on hand revealed attention deficits in each group of patients under study. The decision making time in simple reaction test was longest in schizophrenic patients, significantly longer than in patients with affective disorder. It was also found that chronic schizophrenics performed relatively better in the vigilance test than patients hospitalized for the first time.

Key words: schizophrenia, attention disorders

Introduction

Many years of probing the phenomenon of schizophrenic psychoses by clinicians and theoreticians have failed so far to bring about an understanding of the neurological mechanisms underlying these disturbances. The great variability and colorfulness of the psychopathological picture in schizophrenia, frequent changes in the course of the disease, and disturbances of social functioning, as well as differentiated reactions to pharmacological treatment have provided support for the notion that pathophysiology of schizophrenia cannot be explained on a basis of deficits in a single system or function of the CNS. According to Catalano [1], understanding such deficits requires a thorough application of information theory along with the use of multidimensional scales and cluster analysis to analyze the data. It is currently accepted that the disease symptoms may be related to disturbances in structure or function of different brain regions, to aberrations in the process of forming connections in the CNS, as well as to hypersensitivity to stress during adolescence (see Rybakowski [2]).

The results of many thorough studies on functional disturbances indicate that cognitive disturbances in schizophrenia are accompanied by abnormalities localized in the frontal areas of the brain. These results find confirmation in brain imaging studies by PET and SPECT methods – glucose metabolism and cerebral blood flow – (Berman et al. [3], Andreasen et al. [4,5], Weinberger [7,8]; while Frith and Done [10],

Goldman-Rakic [11,12], Liddle and Morris [13], and Goldberg et al. [14] have shown that cognitive disturbances in schizophrenics are similar to those suffered by patients with injuries to the frontal lobes.

However, neuropsychological tests, designed to determine deficits in cognitive functions, often yielded disparate results when applied to schizophrenic patients (Lezak [15]). Gruzelier et al. [16], Fuentes and Santiago [17], and Granholm [18] found left hemisphere dysfunction, which caused deficits in attention control. Cutting [19] localized it on the right side of the brain, while Weiberger [7], and Morice [21] pointed to bilateral dysfunction in the frontal region. Rushe et al. [22] found generalized amnestic syndromes in chronic schizophrenic, which, according to them, should be linked to bilateral mesiotemporal lobe dysfunction. Wrońska and Jakubowska [23] found qualitatively and quantitatively similar cognitive function deficits in schizophrenic patients in remission and in patients with injuries to the CNS. Barch and Carter [6], and Schuldberg et al. [24] suggest that attention and memory disturbances in schizophrenic patients may be due to a generalized deficit or to common cognitive or neurobiological dysfunction. Liddle and Morris [13] studied homogenous groups of schizophrenic patients and found that the differences in results of neuropsychological tests were related to the differences in symptomatology of the subjects. Addington and Addington [25] continued the studies on mutual relationships between cognitive deficits and negative symptoms of schizophrenia, and in their latest work have not found links between such symptoms and attention deficits in tests repeated 12 months from the acute episode of the disease. There are, however, hypotheses claiming that negative symptoms may obscure the picture of neuropsychological deficits by causing poorer performance on test tasks, (Schuldberg et al. [24]). Such unequivocal results of studies on neuropsychological defects in schizophrenia may be due to such factors as: different methodologies, heterogeneous nature of patients' populations studied, different phases of psychosis, and differences in pharmacological treatments of the subjects.

In the last few decades much interest was devoted to studies of cognitive functions, such as attention, memory and learning, in various nosological entities – schizophrenia, unipolar and bipolar affective disease, and brain traumas (see: Braff [9]; Rubin [36]; Mitrushina [27]; Domańska [28]). These studies facilitated an interdisciplinary approach to the problem, which greatly widened possibilities of understanding the specific nature of brain function disturbances in schizophrenia, and by the same token of the adaptive abilities of these patients (Brekke [29]).

The aim of our study was to compare cognitive disturbances, particularly related to the processes of attention and learning, among groups of patients with schizophrenia, affective disorders, and physical injuries to the CNS – in reference to the group of healthy controls.

Characteristics of the groups under study

The study included altogether 111 persons divided into five groups. One of the groups was that of healthy controls and the other four were comprised of patients fulfilling the ICD-10 [26] diagnostic criteria of schizophrenia, affective disorder and encephalopathies of various origins. All psychiatric patients were examined while relatively free from their symptoms during significant clinical improvement period.

Their current clinical condition was evaluated by the psychiatrist in charge. Persons included in the study had no problems understanding instructions to the tests.

The groups were as follows:

1. **MS Group** (n=19) – patients who were hospitalized for the first time because of schizophrenia; mean age 25.5 ± 1.6 years; mean age of the disease onset 23.7 ± 1.3 years; mean duration of the disease 21.6 ± 6.2 months.
2. **CS Group** (n=20) – patients with multiple hospitalizations because of schizophrenia; mean age 35.4 ± 1.7 years; mean age of the disease onset 22.2 ± 1.2 years; mean duration of the disease 165.9 ± 18.0 months.
3. **D Group** (n=21) – patients hospitalized because of a depressive phase of the affective disorder; mean age 42.3 ± 2.2 years; mean age of the disease onset 33.5 ± 2.5 years; mean duration of the disease 100.3 ± 21.4 months.
4. **O Group** (n=31) – patients hospitalized because of encephalopathies of different origins; mean age 31.3 ± 1.7 years; mean age of the disease onset 25.6 ± 1.6 years; mean duration of the disease 68.4 ± 15.4 months.
5. **K Group** (n=20) – healthy volunteers; mean age 26.7 ± 1.9. On the basis of the qualifying interview they were determined to be free of mental illnesses.

All of the subjects under study were determined to be free from substance dependencies. Previous head traumas concerned only the patients from the **O** group.

The mean age of the MS group was lower than corresponding values for other patients' groups ($p<0.01$) but comparable to the age of the controls, while the mean age of the D group was higher than the means in all other groups ($p<0.01$).

The age of a disease onset in schizophrenia and encephalopathy groups (21–25 years) was significantly lower ($p<0.02$) than in the affective disorder group (ca 33 years). The duration of illness in the group of first hospitalizations (**MS**) was significantly shorter ($p<0.001$) than in other groups of patients, averaging less than two years. The longest duration period of the disease was found in the **CS** group – average over 13 years.

Table 1

The results of standard clinical scales in patients' groups under study (means ± SEM and range of scores)

The clinical state of the patients was assessed with the use of standard clinical

	MS Group	CS Group	D group
SDH	2.6 ± 0.6 (0 – 8)	2.1 ± 0.7 (0 – 10)	4.1 ± 0.6 (0 – 11)
SAPS-G	0.3 ± 0.3 (0 – 7)	0.9 ± 0.4 (0 – 5)	± 0.0 (0 – 0)
SAPS-S	0.9 ± 0.9 (0 – 17)	1.8 ± 0.7 (0 – 12)	± 0.0 (0 – 0)
PANSS	43.9 ± 2.9 (30 – 86)	42.2 ± 2.0 (30 – 61)	34.5 ± 1.1 (30 – 52)
SANS-G	7.4 ± 1.3 (0 – 17)	4.3 ± 0.9 (0 – 12)	2.6 ± 1.1 (0 – 18)
SANS-S	16.2 ± 3.9 (0 – 57)	15.4 ± 3.3 (0 – 54)	4.8 ± 2.6 (0 – 55)

scales: HDS – Hamilton's Depression Scale; SANS – The Scale for Assessment of Negative Symptoms (Andreasen [30]); PANSS – The Positive and Negative Symptoms Scale (Kay [29]); SAPS – The Scale for Assessment of Positive Symptoms (Andreasen [32]).

In all patients' groups depressive symptoms' intensity was within the normal range (0-7 points in a 17 item HDS). Although the depressive features were rudimentary in all patient groups, they were more pronounced in the group **D** than in either of the schizophrenia groups ($p<0.05$).

Symptoms measured by the SAPS-G and SAPS-S scales were found in a very low intensity only in patients with schizophrenia, and they were more evident in the **MS** than in the **CS** group ($p<0.05$). The minimal intensity of the positive symptoms testifies to the fact that during the study the patients were, as expected, in a relative remission period.

In both groups of schizophrenics the intensity of symptoms evaluated by the scales SANS-G and SANS-S was similar, regardless of the course of the disease, and higher than in the group **D**.

In the **MS** group the intensity of symptoms measured by the SANS-G and SANS-S scales was higher than in other patient groups ($p<0.01$) and the **CS** group scored higher on both scales than the group **D** ($p<0.05$).

The results of clinical scales do not correlate either with the age of the patients or with the up to the present course of the disease. The results of the ESRS scale, which measures the intensity of extrapyramidal symptoms (Chouinard et al. [33]), were normal for all of the patients.

Average current medication level of the MS group (in chlorpromazine equivalents) was 300 mg (75 – 500), and in the CS group 230 mg (100 –500). Patients from the affective disorder group were taking sustaining doses of various antidepressants.

Research tools

The following procedures of the Vienna Test Battery were applied:

- The R-Unit Test, measuring decision time, motor reaction time, and total reaction time to simple and complex optic and acoustic signals. Of these prameters, we used in this study only the decision-making time following simple light stimulus, and the decision making time of choosing the proper light stimulus as measures of information processing speed (Vienna Test System, Vienna 1994).
- The Vigilance Test, measuring the sustainment of attention focusing in visual tasks involving recognition and reaction to slight modifications of the setup.
- The Perseveration Test, measuring the tendency to develop stereotypic responses.

The test tasks applied in here allow to evaluate the speed of performance, and the concentration and sustainment of attention. The tasks in these tests are presented on the computer screen, and the subject performs them either with the help of a light pen or using the keys of a special keyboard. Reaction times are measured on the apparatus made of a special plate with two lights and a reaction push button. In these tests

the subjects are not required to remember the stimulus but only to react immediately upon noticing it.

The results were evaluated with the help of a statistical software package "Statgraphics". The independent sample means were compared by Two Sample Analysis procedure and Pearson's correlation factors with their significance values were determined by Correlation Analysis procedure.

Ability to focus attention on the performed task

Table 2 contains the mean results of the tests for all of the groups:

Decision time (ms) after noticing the yellow light on the plate in front of the subject (simple reaction – CDP).

Decision time (ms) after noticing simultaneous appearance of red and yellow lights on the plate (reaction with choice – CDW).

The number of properly registered departures from regular movement (LPW) of a point travelling around the circle (out of 30 such instances in this test) and the number of false indications (LFW) in the same task.

Percentage index of involuntary application of repeatable schemes following instructions recommending random indication of fields presented on the screen (the perseveration test, redundancy – RED).

Table 2

The results of test of the ability to focus attention on the task on hand (Means ± SEM)

	MS Group	CS Group	D Group	O Group	K Group
CDP	325 ± 13	317 ± 12	306 ± 12	345 ± 14	279 ± 13
CDW	401 ± 18	387 ± 16	394 ± 11	406 ± 16	370 ± 16
LPW	28.8 ± 0.4	29.5 ± 0.1	29.5 ± 0.1	28.4 ± 0.3	29.9 ± 0.1
LFW	0.7 ± 0.2	1.6 ± 0.7	0.6 ± 0.2	1.5 ± 0.4	0.3 ± 0.2
RED	48 ± 6	45 ± 4	36 ± 3	46 ± 3	31 ± 3

In all patients' groups decision time of a simple reaction was significantly longer than in the K group ($p<0.01$). The **D** group performed on this task significantly better than other patient groups ($p<0.05$). Both groups of schizophrenics did dot differ significantly between themselves, but both reacted more quickly than the **O** group ($p<0.05$).

In all of the groups the task of making decision with a choice has taken significantly longer than making decision about a simple reaction ($p<0.001$). All the patients' groups were significantly slower on this task than healthy controls ($p<0.02$). The differences observed among the groups of patients did not achieve the level of statistical significance because of a large scatter of results.

In the vigilance test, which requires focusing attention on a monotonous task and reacting to small deviations from routine, all the patients' groups demonstrated significantly lower vigilance ($p<0.03$) than the group **K** of healthy subjects. Patients from the **O** and **MS** groups performed significantly worse in this test than patients of

the **CS** and **D** groups. The second parameter evaluated in this test was the number of "false alarms". These were more frequent in every group of patients in comparison to the control group. A significantly higher than in other groups of patients tendency for "false alarms" was registered in the groups **CS** and **O** ($p<0.05$).

A tendency to act schematically (RED), which may be interpreted as a difficulty in focusing attention on random performance (in this test – pointing to the fields on the plane), is much stronger ($p<0.01$) in patients with schizophrenia (regardless of the time of disease duration) and in patients with encephalopathy, than in patients with depression or healthy controls.

Analysis of the interrelations among the variables

In the group of healthy controls we found correlations between the time of simple decision and the time of a decision with choice in the R-Unit Test; the number of properly indicated departures from regular movement (LPW), and the redundancy index (RED) – Pearson's correlation coefficients r: 0.66; -0.45; 0.48 respectively. There also was a correlation between the number of proper indications of departure from regularity (LPW) and the number of "false alarms" (LFW) – $r = -0.83$, which indicates a connection between increased number of omissions and the number of improper, impulsive reactions. In addition, the time of a reaction with choice correlated positively with the age of the healthy subjects ($r = 0.49$). Among the patients, only the correlation between simple decision and decision with choice times was found ($r = 0.52$; 0.72; 0.57; 0.65 for the MS, CS, D and O groups respectively). There were also no correlations of the measured indices with the age or the disease duration time in these groups.

Discussion

As expected, all the patients' groups performed worse in the concentration of attention measuring tests than healthy controls. The patients with affective disorder diagnosis performed better than other patients' groups. This seems to be in agreement with the observation of Williams et. al. (cf. Goldberg [34]) those neuropsychological deficits in depression have a tendency to disappear in full remission periods. The results of Kasperska et al. [35] indicated even that a group of patients with diagnosed affective disorder performed the test of continuous attention test on the level similar to that of the healthy subjects. We think that this phenomenon deserves further studies.

Our expectation that the group of schizophrenic patients hospitalized for the first time would perform better the group of chronically ill was not confirmed in this study. This may support the notion of other authors that cognitive deficits in schizophrenia are stable over time and are more of a trait than a state feature (Kraepelin [37]; Sobizack [38]), concerning mainly the patients with a delusional form of the disease (Seltzer et al. [39].

In the vigilance test, measuring among others the number of proper reactions, the MS group performed significantly worse than the CS group. This may be treated as a confirmation of the fact that attention disturbances are present from the very begin-

ning of the illness, and perhaps are present even before it's onset (Cornblatt [40,41]; Rybakowski [2]).

The chronic schizophrenics did, however, appear to be more impulsive (rush reactions, higher number of "false alarms" - LFW), more disinhibited, which makes their behavior in this respect more similar to that of ten patients with organic CNS damage.

The higher index of stereotypic reactions in both groups of schizophrenics can be interpreted as a certain measure of disturbed control of behavior. The patients are unable to permanently adjust their reactions to the instructions received, which results in the appearance of rigidity in problem solving and behavior. Similar difficulties were observed in patients with encephalpathies of different origin. In the present study such deficit was absent in the group of patients with affective disorder.

The question, whether the worse test results obtained by all the patients, as compared to the controls, were due to the slowed down information processing or to the disturbances in the processes of perception and selective inhibition, or perhaps to all these factors jointly, remains open (Randolph et al. [20]).

Conclusions

1. In all of the patients' groups under study evident disturbances of attention focusing on the task on hand were found, manifested by a prolonged – in comparison to the controls – time of decision, and increased number of errors in tasks requiring sustained concentration.
2. The groups of patients with schizophrenia had more difficulties in performing the tests than the group of patients with affective disorder. All of the patients were tested during a remission of symptoms period.
3. It appears surprising that the group of chronic schizophrenics performed the vigilance test better than the group of the first-admission patients. This may be interpreted as a manifestation of some kind of adaptive processes in people that have been sick for a long period of time.

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