

NEUROPSYCHOLOGICAL PROFILE OF DELUSIONAL DISORDER

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SUMMARY

Background: Previous studies concerned with neuropsychological aspect of delusions, were mainly focused on specific forms of this disorder, such as Cotard or Capgras type of delusions. Comparatively small numbers of investigations were concerned with cognitive deficiencies accompanying the delusions. The substance of this study includes the detection of neuropsychological dysfunctions in patients with delusional disorder, and tracing of these cognitive distortions to appropriate brain regions.

Subjects and methods: The investigation is designed as a comparative study. Inpatients with delusion are compared with normal subjects from the aspect of the following cognitive functions: attention, memory, visuospatial and visuoconstruction organization, executive ability, verbal divergent thinking.

Results: Attention, memory (verbal modality) and psychomotor skill tasks are most susceptible to delusional effects.

Conclusion: The neuropsychological profile of patients with delusional disorder includes impediment of complex attention modalities. From this primary disorder, there also stems a disorder of verbal memory in the sense of reduced recognition. These cognitive distortions suggest a dysfunction of the anterior regions of the cerebrum, mainly of the prefrontal and sinistral temporal regions.

Key words: delusional disorder - neuropsychological profile - cognitive function

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INTRODUCTION

The subject of the definition of delusion still occupies the attention of many psychopathologists and investigators in this area. The problem is further complicated by the fact that delusional beliefs may be encountered, although in a less pronounced form, in individuals who have never requested or received psychiatric treatment (Peters et al. 1999, Van Os, et al. 2000). Beside the previously mentioned, the etiology of delusional disorders is also unknown (Ghoreishi 2008).

Neuropsychological studies of delusional disorders are still at their initial stage. As in most psychiatric conditions, there is no evidence of localized brain pathology that would correlate with clinical psychopathology. Delusions may complicate practically all brain disorders, including epilepsy, cerebrovascular disorders, brain trauma, brain tumor, Huntington's chorea and also autoimmune and endocrine disorders (Kunert et al. 2007). The question is, whether a cognitive deficiency is present in these conditions which could be related to appropriate brain regions, or

whether this assumption is only fictional. The fact is that thorough neuropsychological investigations of this psychopathological entity are lacking, probably because in the patients with delusional disorder, formal thinking and memory impairments, as well as disorders of other cognitive functions are not recorded (Bömmner & Brüne 2007).

Currently available studies that are concerned with neuropsychological aspects of delusions, are mainly focused on specific forms of this disorder, such as Cotard and Capgras delusions, i.e. on such delusional disorders which are accompanied with unusual, irregular experiences (Garety & Freeman 1999, Maher 1999). Bentall (1990) recommended a simple model which suggests that events must be observed and monitored if they are to induce the formation of convictions. Once an individual has noticed an event, various kinds of concluding strategies may be applied in order to determine its meaning and importance.

Seeking of further information may lead to the events confirming some conviction, rejecting it or requiring its modification.

Comparatively few studies are concerned with cognitive dysfunctions related to delusional disorders, thus making relevant data very scarce. These studies mainly describe increased perceptive abilities and attention disorders that may play an important role in delusional genesis (Davis & Gibson 2000), an excessive need for closure, as well as the inclination of these individuals towards jumping to conclusions (Colbert & Peters 2002).

Neuropsychology of delusional disorders represents an incomplete picture within which temporal and limbic dysfunctions are mentioned with uncertainty (Howard et al. 1995) as well as a possible specific neuroanatomic substrate of this disorder. Cummings (1992) suggests in his study that delusions occur in diseases including the limbic system - especially the structures of the temporal lobe and n. caudatus. Diseases characterized with excessive dopaminergic activity, also, bear an increased tendency towards delusional thinking. According to this hypothesis, the usual locus of delusion formation is dysfunction of the limbic system which makes a person predisposed to wrong interpretation of the environment together with inappropriate perception of a threat. Both factors, the one connected with the disease and the one connected with the patient, influence the content, complexity and timing of delusions.

When cognitive dysfunctions are encountered in delusional patients, it is necessary to determine their nature and course. They are established by a neuropsychological battery of tests among which each one estimates certain aspect of cognitive function, by investigating the relationship between the delusional disorder and the outcomes of the test including different modalities of cognitive functioning and by determination of the profile disorder that would be specific for a certain diagnostic group or symptom group.

The present study had three aims: to establish the specific neuropsychological profile of patients with delusions in the phase of remission, to find the cognitive functions most susceptible to delusion effects, and, to find the connection between neuropsychological dysfunctions in patients with delusional disorder and brain localization.

SUBJECTS AND METHODS

The investigation involved 60 subjects, of both sexes, aged between 30 and 53, There were: 30 patients with delusional disorder, diagnosed on the

basis of Structured Clinical Interview for DSM-IV (SCID-I; First et al. 1997), hospitalized in the Institute of Psychiatry of the Serbian Clinical Center and 30 healthy individuals. The subjects from the delusional disorder group with delusional symptomatology connected with neurological diseases, organic psycho-syndromes, schizophrenic psychoses, somatic diseases and those with neurological disorders such as head trauma, brain insult, epilepsy, were excluded. Also the subjects with recorded alcohol or substance abuse were excluded. In the delusional disorder group, the duration of the disorder varied between six months and three years, with average value of 1.87 years, and the number of hospitalizations between one and two, with the average value of 1.04. The delusional disorder group was in the phase of clinical remittance, which is shown by average score value (= 48.25; SD = 3.42) in PANSS (Kay et al. 1988).

The healthy group was selected on the basis of good results in overall health tests, from the population of individuals who came regularly every six months to the medical test necessary for those employed in education, catering or as food sellers. In their personal or family history there was no data on psychotic or neurotic disorders, substance or alcohol abuse.

All the subjects were right-handed, in application and gesture, which had been confirmed by a scale for hand use dominancy estimation (Raczkowski et al. 1974). They gave their consent to be deliberately tested. Each group included 18 males and 12 females.

Neuropsychological tests

A neuropsychological battery was applied to each subject, including the following tests:

- MMSE - Mini Mental State Examination (Folstein et al. 1975);
- VITI - Wechsler's Individual Test of Intelligence (Berger et al. 1991);
- TMT - Trail Making Test (Reitan 1958);
- HVOT - Hooper Visual Organization Test (Hooper 1983);
- RCF - Rey-Osterrieth Complex Figure (Rey 1941, Osterrieth 1944);
- RAVLT - Rey Auditory Verbal Learning Test (Rey 1964);
- WCST - Wisconsin Card Sorting Test (Berg 1948).

Methods of statistical data processing

Data processing was performed by standard statistical procedures in SPSS (SPSS 2007). Within descriptive statistical analysis, variability measures in the given sample were calculated for all relevant variables (minimal value, maximal value and standard deviation), as well as the measure of central tendency (mean value).

Within inferential statistics, statistically significant differences between the investigated groups were analyzed, by t-test, for each of monitored characteristics (demographic characteristics, scores from neuropsychological tests).

RESULTS

In Table 1 the general group characteristics (age, education level and achievements in MMSE) are presented. The groups do not differ in age ($t(58) = 0.01, p > 0.05$), educational level ($t(58) = 0.14, p > 0.05$) and MMSE scores ($t(58) = 0.46, p > 0.05$).

Achievements of the analysed groups in VITI are presented in Table 2.

By the analysis of intergroup differences in the verbal part of VITI, it has been found that the delusional disorder group differs significantly from the healthy group in the subtests Information ($t(58) = 2.74, p < 0.01$) and Vocabulary ($t(58) = 2.45, p < 0.05$). Although these subtests measure conceptual abilities, the obtained difference is, most likely, a consequence of a poor fund of general knowledge in the delusional disorder group in comparison with healthy subjects. The groups differ significantly also in the subtest Digit Span, $t(58) = 2.57, p < 0.05$, which reflects the verbal range of attention and short-lasting verbal memory.

In the performance part of VITI, the delusional disorder group is significantly different from the control healthy group in the subtest Digit Symbol, $t(58) = 2.04, p < 0.05$, which measures visuomotoric coordination and grapho-motoric abilities and represents an indicator of working memory.

Table 1. Main demographic and cognitive characteristics of the groups (means – χ^2 , standard deviations – SD, t-test, p values)

Parameters	DD $\chi^2 \pm SD$	H $\chi^2 \pm SD$	t-test	p values
Age	41.70±6.57	41.73±6.59	0.01	$p > 0.05$
Education level	13.46±2.62	13.56±2.54	0.14	$p > 0.05$
MMSE	28.43±1.52	28.60±1.24	0.46	$p > 0.05$

DD – delusion disorder group; H – control healthy group

Table 2. Achievements of the groups in VITI; (means – χ^2 , standard deviations – SD, t-test, p values)

Variable	DD $\chi^2 \pm SD$	H $\chi^2 \pm SD$	t-test	p values
IQt	103.86±10.31	110.83±8.97	2.79	< 0.01
IQv	104.83±10.43	111.03±0.05	2.34	< 0.05
IQp	102.80±11.18	108.13±9.00	2.03	< 0.05
Information	17.30±6.13	21.50±5.69	2.74	< 0.01
Digit Span	12.73±2.76	16.23±6.92	2.57	< 0.05
Vocabulary	43.40±14.33	52.43±14.17	2.45	< 0.05
Arithmetic	11.29±2.99	11.50±3.03	1.68	> 0.05
Comprehension	17.13±5.79	19.30±5.01	1.54	> 0.05
Similarities	18.06±6.48	19.83±4.53	1.22	> 0.05
Picture	11.93±4.27	12.06±2.98	0.14	> 0.05
Completion				
Picture	8.23±4.92	9.96±4.65	1.40	> 0.05
Arrangement				
Block Design	34.90±8.79	37.46±6.06	1.31	> 0.05
Object Assembly	23.63± 7.23	26.66±6.69	1.68	> 0.05
Digit Symbol	41.56±10.82	47.56±16.15	2.04	< 0.05

DD – delusion disorder group; H – control healthy group; IQt - full scale IQ; IQv – verbal IQ; IQp – performance IQ

Inter-test analysis in the delusional disorder group, which is of relevance only within individual VITI procedure, indicates a tendency towards an increase of achievement in the subtest Picture Completion which engage concentration to visually perceived contents with the purpose of discovering inconsistencies in the given material. Subjects from this group achieve higher scores in supplements in comparison with their individual average results.

From the aspect of full scale IQ, the delusional disorder group differs significantly from the healthy group, $t(58) = 2.79$, $p < 0.01$. The delusional disorder group differs significantly from

the healthy group, both in verbal IQ ($t(58) = 2.34$, $p < 0.05$) and in performance IQ ($t(58) = 2.03$, $p < 0.05$). The differences arise due to lower achievements of the delusional disorder group compared with the healthy group, in the subtest Information, Digit Span and Vocabulary within the verbal part of VITI and poorer score in the subtest Digit Symbol within the performance part of VITI. Regardless of the observed differences in full-scale IQ, the values indicate that the groups are within the range of an average intellectual functioning (90-110).

Achievements of the analysed groups in neuropsychological tests are presented in Table 3.

Table 3. Achievements of the groups in neuropsychological tests (means – χ^2 , standard deviations – SD, t-test, p values)

Variable	DD $\chi^2 \pm SD$	H $\chi^2 \pm SD$	t-test	p values
TMT A	43.46±14.83	47.00±10.68	1.05	> 0.05
TMT B	134.80±41.50	92.06±9.52	-5.10	< 0.01
HVOT	24.08±1.94	24.55±2.40	0.82	> 0.05
RCF - C	28.93±4.08	29.75±2.85	0.89	> 0.05
RCF - 40 ^{cc}	15.21±6.31	14.15±4.35	0.76	> 0.05
RAVLT t	42.63±7.68	46.50±7.83	1.92	> 0.05
RAVLT e	8.6±1.52	8.90±1.09	0.87	> 0.05
RAVLT r	10.53±1.07	12.93±1.11	8.50	< 0.01
CA	5.43±1.00	5.36±1.06	0.24	> 0.05
FMS	1.86±1.22	0.26±0.52	-6.58	< 0.01
PR	47.82±28.48	48.36±27.20	0.98	> 0.05

DD – delusion disorder group; H – control healthy group; RCF C – copying of the RCF; RCF 40^{cc} – postponed visual memorizing of the RCF; RAVLT t – total number of repeated words in five attempts in the RAVLT; RAVLT e – number of repeated words after 30 min (evocation) in the RAVLT; RAVLT r – number of correctly recognized words (recognition) in the RAVLT; CA – categories achieved in the WCST; FMS – failures to maintain set in the WCST; PR – perseverative responses in the WCST

The delusional disorder group shows a significant deviation in achievements in TMT B, i.e. a prolonged duration, compared to the healthy group, $t(58) = -5.10$, $p < 0.01$. Form B is a measure of a more complex conceptual following and represents the efficiency of divided attention.

Ability of recognition (RAVLT r) of previously learned words is significantly reduced in the delusional disorder group in comparison with the healthy group, $t(58) = 8.50$, $p < 0.01$, so these patients have a narrowed range of remembered data at their disposal.

Analysis of the significance of differences between the investigated groups in WCST shows that significant differences are observed only at the parameter representing the total number of interruptions in a set (WCST fms). The delusional disorder group has significantly more failures to

maintain a set than the control healthy group, $t(58) = -6.58$, $p < 0.01$, which indicates some hindrances in prolonged attention.

DISCUSSION

The obtained results of our investigation show that the tasks of attention, memory (verbal modality) and psychomotor skill are those most susceptible to delusion effects, because the achievements of the delusional disorder group in these tasks are the ones deviating significantly from the healthy group. In other tests, namely, in those concerning visual memory, simple conceptual following, visuo-spatial organization and executive functions no differences were found between patients with delusional disorder and healthy subjects. However, considering that the

neuropsychological testing was not performed in the active disease stage, it is uncertain whether preservation of the mentioned functions in subjects with delusional disorder is the result of their recovery in the remission phase due to "cognitive consolidation", or whether they had not been impaired at all during the delusion episode. It is also unclear whether the observed deficit was of the same order in the active phase or there occurred a parallel improvement of cognitive functioning during clinical recovery.

It is interesting that, although in the context of the statistical analysis there are statistically significant differences between the delusional disorder group and healthy individuals which are unfavorable for the affected subjects, the lower scores observed in this group are generally not clinically significant from the perspective of cognitive deterioration. For instance, the patients had the mean IQ value far below the one for the healthy group, but it was still within average values. However, our sample was at a high education level, with full scale IQ at the average level, i.e. it included the subjects with solid "cognitive storage", which in a way limits our conclusions on delusional patients in general. Actually, it is doubtful whether the hindrances in cognitive functioning would be more marked if the sample included subjects with a lower IQ and lower educational level. In any case, on the basis of the obtained results it still may be concluded that the delusional disorder group as a whole did not express cognitive defects that could be of clinical significance such as dementia indicators, in spite of statistically significant deviations from healthy subjects. The presence of deterioration symptoms in delusional subjects is apparent in a very mild degree that excludes any possibility of dementia development that would be connected with a further course of the illness.

The results of our investigations confirm that in delusional disorder there exists, in a milder form, cognitive dysfunction in the remission phase, indicating that the disorder is permanent.

According to our knowledge, no neuropsychological study on delusion has appeared so far that is designed in the same way as the present study, making it thus impossible to compare our conclusion on dysfunction of anterior regions of cerebrum, mainly of prefrontal and sinistral temporal regions, with the results of other methodologically similar investigations.

Analysis of neuropsychological functions in patients with delusional disorder

General cognitive ability, on the basis of full scale IQ, ranges in both groups was within the average intellectual functioning (90-110). Although the difference in IQ between the healthy and the affected group is statistically significant, it still may be said that the groups were in accordance with general intellectual level, because in both cases it ranged within average values. Besides, the arithmetic mean values MMSE of none of the investigated groups were lower than 24 points, which represents the border value beyond which dementia may be suspected. These results show that a possible negative influence of general cognitive abilities on other neuropsychological functions is avoided.

On verbal scale VITI, significant differences are present between the group with delusional disorder and the control healthy group, in the following tests: Information, Digit Span and Vocabulary.

Low score at Vocabulary and Information tests, which are mediated by left temporal lobe, indicate primarily a limited educational level. Clinical experience shows that the original psychic disorder corresponds, to a degree, with the strength of adaptive intellectual function. In some cases, which may include the delusional disorder group, this may be a consequence of a pronounced disinclination towards verbal expression. If these achievements are compared with the picture version of Vocabulary subtest, i.e. Picture Completion subtest, in which these patients achieve high scores, then this disinclination becomes very obvious.

Poorer achievements of the delusional disorder group in the Subtest Digit Span indicate a reduced ability of attention maintenance and immediate memorizing. Attention corresponds to quick energy mobilization which is not specifically connected with any specific interest, affect or aspiration. Beside imbalanced affects, attention may be occupied with emotion charged ideas, such as delusions.

On manipulative scale VITI, delusional disorder group shows a significant decrease of achievements, in comparison with the healthy subjects, in Digit Symbol test. Such finding indicates an impaired psychomotor speed that may be slackened in patients with delusional disorder

due to pronounced perfectionism (Biro 1999) and the need to investigate the stimulus field in detail, which is more time consuming. This is supported by a tendency towards higher scores in the subtest Picture Completion, within the individual protocols.

Achievements in the subtest Picture Completion is, in more than a half of patients with delusional disorder, the best achievement within the individual scores. Most patients from this group achieve higher-than-average results in Picture Completion test, in comparison with their own averages. This subtest especially contributes to the evaluation of the subjects from the delusional disorder group, because a thorough examination of the stimulus field does not lead, as in some other subtests, to lower achievements. On the other hand, Picture Completion suits these patients because their perception is preserved and even heightened, but the ability of verbal production is poorer.

Patients from the delusional disorder group are less successful than the healthy subjects in simple verbal attention (Digit Span from VITI). Also, the delusional disorder group expresses disturbances of divided attention (TMT B), i.e. a significant prolongation of the time necessary for the completion of the task of complex visual conceptual following compared to the healthy group. Divided attention enables simultaneous focusing on more than one relevant stimulus and is mediated with dorsolateral prefrontal cortex and anterior gyrus cinguli.

Slackening of psychomotor skills has a significant impact on achievements in the tests that contain a motor component (Rogers, Lees, Smith, Trimbel & Stern 1987) as well as in those that are time-limited. However, this slackening is, as we have already shown in the delusional disorder group, the result of a detailed scanning of the stimulus field in order to include all the data into cognitive processing. Under comparatively simple conditions, this scanning is performed quickly enough, the same as in healthy subjects. In more complex situations (TMT B), that require divided attention, the time necessary for the examination is significantly prolonged, in order to achieve a sure detection of possible threatening or less obvious stimuli. The assumption that in the delusional disorder group there is no psychomotor skill slackening per se is supported by the fact that in

other tests that are time-limited there is no any significant slackening.

In the delusional disorder group, there is also present a substantial disturbance of prolonged attention (WCST - more frequent failures to maintain set), which is mediated by dextral frontoparietal systems, in comparison with the control group of healthy subjects. Such hindrances reflect the difficulties of long-lasting focusing on one stimulus. This disturbance found in patients with delusional disorder may arise from the following reason: if the activity is neutral from the aspect of a possible threat, attention is transferred to the surrounding in order to search further for possible, threatening stimuli.

The range of immediate memorizing of verbal material is significantly narrowed in the delusional disorder group in comparison with the healthy group. Organization of this function is, to a substantial degree, aided by attention, so these deficiencies may be a consequence of a primary attention disorder that influences the disorders in the memory sphere. Namely, attention disorder influences the achievement in many fields, among which is the determination of short-term memory content (Očić 1998).

As for the postponed recollection (recognition) which has been analysed on the basis of the results in RAVLT test, the delusional disorder group lags significantly behind the healthy group. It is interesting that the delusional disorder group keeps up in free recollection (evocation) with the healthy group, although this requires more cognitive effort than recognition. More requiring tasks, like evocation, mobilize attention in these patients in an adequate way and lead to satisfying results, if time limit is not set as the key factor of the success. On the other hand, tasks of recollection, although simpler, require preserved divided and prolonged attention, in order to simultaneously perform approach to information which is in depots of recent long-term memory and a quick scanning of several data sequences (recollection of a word list and classification of learned material into three categories).

The root of verbal memory disturbance in patients with delusional disorder is neither a learning problem, nor deficient strategies of recollection or a low degree of cognitive effort, but more probably a primary attention disturbance leads to the reduction of capacity for remembering information.

Neuropsychological profile of the patients with delusional disorder

The results of neuropsychological investigations indicate a possible model of cognitive processing of information in patients with delusional disorder, which is based on a primary disorder at the level of information reception (input): recorded tendency towards perception of all stimuli from the stimulus field influences the hindrances in attention and compromises it in its complex modality, both in the divided, and in the prolonged form. Considering that the normal attention range is 7 ± 2 pieces of information, this limitation does not allow perception of all the stimuli from the stimulus field. However, for patients with delusional disorder, all pieces of information are equally important, so these patients are not capable to perform quickly the selection of "important-unimportant" type when the stimulus field is more complex. This defect at stimuli perception is also responsible for a narrowed attention range and for influx of random information into the short-term memory (composition of important and unimportant data), due to which the pieces of information are connected poorly or not at all. The lack of connection between received data is surpassed by a delayed search for the meaning attributed to the events. Pieces of information received and processed in this way are a part of the depots of recent long-term memory where the hindrances in postponed recollection (impaired recognition) are evident, i.e. the capacity of remembered information is decreased due to a primary attention disorder.

CONCLUSION

Neuropsychological profile of patients with delusion disorder in remission phase, after delusion episode, includes attention deficiency situated within its verbal range, as well as the deficiencies of divided and prolonged attention. From this primary disorder, there stems the disorder of verbal memory in the sense of reduced recognition, i.e. a decreased capacity to memorize in spite of the preserved mechanism for scanning of previously obtained information.

In patients with delusional disorder, an inclination is apparent towards intensified processes of perceptive organization that lead to careful and thorough scanning of the stimulus

field, in order to ensure that all the stimuli are included into the input. This mechanism could be the root of delusion origin.

Neuropsychological profile of patients with delusional disorder suggests dysfunctions of anterior regions of cerebrum, mainly of the prefrontal and sinistral temporal regions.

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