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ORIGINAL PAPER

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Disorganization and cognitive impairment in schizophrenia: independent symptom dimensions?

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Abstract Cognitive deficits are increasingly considered as essential in schizophrenic disorders. Positive symptoms and cognitive deficits have been found to be independent, whereas negative symptoms show only weak correlations to cognitive impairment. However, the relationship to a third symptom dimension, disorganization, is yet unclear. In a sample of $n = 151$ schizophrenia inpatients (DSM-IV/SCID) we assessed cognitive impairment using a comprehensive neuropsychological test battery and symptoms of schizophrenia applying the Positive and Negative Syndrome Scale (PANSS). Factor analyses resulted in three neuropsychological (attention, memory, abstraction) and five symptom factor scores (negative, impulsiveness, positive, disorganization, depression). The disorganization factor did not correlate significantly with any of the neuropsychological factor scores. Even after controlling for different demographic and clinical variables partial correlation coefficients did not reach a significant level. Thus, we could not confirm the previously reported associations between disorganization and measures of cognitive impairment. Despite a considerable conceptual overlap between interview based symptom ratings and classic neuropsychological tests the empirical association is limited. Our results suggest that disorganization and cognitive impairment represent different symptom dimensions.

Key words schizophrenia · neuropsychology · cognitive impairment · psychopathology · disorganization · PANSS

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Introduction

Cognitive deficits are increasingly considered as essential in schizophrenic disorders. There is convincing evidence that secondary memory, executive functions, and attention are impaired in schizophrenia [14]. As a consequence, the question arises whether symptoms of schizophrenia as measured with standard symptom rating scales and cognitive impairment as assessed with neuropsychological test batteries are associated. Investigating this question could possibly help identifying meaningful schizophrenic syndromes [6, 33]. Positive symptoms and cognitive deficits have been found to be independent, whereas negative symptoms show only weak correlations to cognitive impairment [12]. However, the relationship to a third symptom dimension, disorganization, is yet unclear.

Liddle [23] introduced disorganization as an important third factor in addition to the positive (reality distortion) and negative (psychomotor poverty) symptom factor. He identified inappropriate affect, poverty of content of speech, and disturbances of the form of thought as an own factor and hypothesized that the different syndromes reflect different neurobiological alterations [22]. However, up to now there is no consensus about the number and the symptoms to be included in a disorganization factor. The different symptom rating scales are het-

erogeneous regarding included symptoms and factor structure. With regard to the Positive and Negative Syndrome Scale [PANSS, 19] the items "formal thought disorders", "difficulties in abstract thinking", and "lack of attention" seem to be the core items of a disorganization or cognitive factor [7, 26, 34] despite partially inconsistent findings [16]. Disorganization has obviously some conceptual overlap with neuropsychological constructs as abstraction and attention.

Standard neuropsychological tests are designed to reliably assess specific cognitive functions under controlled and highly structured conditions. However, the interpretation of single test data is limited due to the fact that tests always assess a variety of basic cognitive functions [20]. For example, a test for the assessment of executive functions almost always implicitly assesses attention, memory and language. Therefore, tests are usually applied as part of more comprehensive test batteries in order to cover a broad range of underlying functions. On the other hand, this strategy leads to a considerable heterogeneity of test batteries across different studies even when comparable areas of dysfunction are to be assessed.

The correlation of symptom measures and neurocognitive impairment was investigated by Nieuwenstein et al. [31] in a meta-analysis which included studies using the Wisconsin Card Sorting Test (WCST) and the Continuous Performance Test (CPT). The highest correlation between symptoms and the WCST was 0.4, between symptoms and the CPT 0.16. They criticise that samples are small and the test batteries applied are non-comprehensive. As the PANSS does not include disorganization as a standard factor, most of the studies using PANSS did not report correlations between disorganized symptoms and cognitive tests. Mass et al. [26] reported 0.29 as the highest correlation between PANSS disorganization and the Continuous Performance Test (sensitivity d'). Bell [4] found a correlation of 0.4 between a PANSS cognitive factor and the WCST. Using SANS and SAPS O'Leary et al. [33] found 0.27 as the highest correlation between a comprehensive test battery and disorganization. Good et al. [10] investigated the same question in neuroleptic-naïve patients. They argued that neuroleptic treatment reduces symptom severity, and therefore, leads to only weak correlations between tests and symptoms. However, they found correlations between 0.04 and 0.43 that are not much higher as in patients treated with antipsychotic medication.

Altogether, the relationship between disorganization as assessed with the PANSS and cognitive tests remains unclear and should be investigated further. This paper will firstly analyse the factorial structure of both the PANSS and a comprehensive neuropsychological test battery. Secondly, it will analyse the correlation between a PANSS disorganization factor and the cognitive impairment as reflected in factorised test scores, in order to take the intercorrelations of single tests into account. Finally, it will analyse moderating factors of the symptom test correlation.

Method

Patient Selection

Between April 1998 and June 2001 169 inpatients who met DSM-IV criteria for schizophrenia or schizoaffective disorder were consecutively recruited as part of a combined large-scale psychotherapy and neuropsychology study at Tuebingen University Hospital, Department of Psychiatry and Psychotherapy, and the Rottweil state hospital of psychiatry and psychotherapy (Germany). Diagnoses were determined by the German version of the Structured Clinical Interview for DSM-IV Axis I Disorders [SCID-I; 37]. All patients gave written informed consent to participate in the study, which was approved positively by the local ethics committee. Patients were selected on the basis of the following inclusion criteria: (1) stabilization phase of illness, and (2) ages between 18 and 60 years. Exclusion criteria for neuropsychological testing were as follows: (1) lifetime history of substance dependence or substance abuse (DSM-IV/SCID-I) during the last month before recruitment, (2) neurologic disease or damage, (3) medical illnesses that may interfere with cognitive function, (4) history of head injury with loss of consciousness greater than five minutes, (5) mental retardation (IQ below 80 according to the MWT-B [21], a German vocabulary test measuring the premorbid intellectual level), and (6) insufficient German language skills. The diagnosis of two patients had to be changed later to a bipolar affective disorder with psychotic symptoms. These two patients were excluded from the analysis. Additional 16 patients refused to participate in the neuropsychological examination. Thus, test data of 151 patients are available.

Control group

In order to obtain a matching sample we randomly selected 40 cases out of our patient group. Matching criteria for the normal controls were age (±3 years), gender, and education (elementary school, secondary school, or high school). We recruited these 40 normal controls through advertisements in the catchment area of the hospital. Beyond the matching criteria normal controls had to fulfill the following inclusion criteria: (1) no history of psychotic or affective disorders (DSM-IV/SCID-I), and (2) currently no taking of psychotropic medications. Additionally, controls qualified as non-vulnerable individuals, as they did not present any history of psychotic or affective disorders among their first-degree relatives. Exclusion criteria for the normal controls were identical with those of patients'.

Demographic and clinical characteristics

Table 1 shows the demographic and clinical characteristics of the two groups of probands. Patients and controls showed no significant differences with regard to age, gender, and education.

Schizophrenia subtypes (DSM-IV/SCID-I) of the patient sample are listed in Table 1. Clinical symptom assessment in patients had to be completed within two weeks prior to neuropsychological testing. The median between symptom assessment and testing was 5 days. The interviewers used the Positive and Negative Syndrome Scale [PANSS, 19]. Table 1 shows the ranges for the mean item scores along with the sum scores for the PANSS scales. The moderate level of the PANSS scores implies that patients were neuropsychologically assessed in the stabilization phase of their illness. Nevertheless, approximately 25% of the patient sample presents positive or negative symptoms above a rating of 3

Table 1 Demographic and clinical characteristics of subjects

	Patients (n = 151)	Controls (n = 40)	P
Age[a] M (SD)	33.6 (10.3)	33.3 (9.7)	0.850
Gender[b]			
Female	78 (51.7%)	20 (50.0%)	0.861
Male	73 (48.3%)	20 (50.0%)	
Education[c]			
Elementary school	43 (28.5%)	7 (17.5%)	0.359
Secondary school	56 (37.1%)	18 (45.0%)	
High school	52 (34.4%)	15 (37.5%)	
Diagnoses (DSM-IV/SCID-I)			
Schizophrenia			
Paranoid type	92 (60.9%)		
Undifferentiated type	17 (11.3%)		
Disorganized type	11 (7.3%)		
Catatonic type	5 (3.3%)		
Residual type	9 (6.0%)		
Schizoaffective disorder			
Depressive type	7 (4.6%)		
Bipolar type	10 (6.6%)		
PANSS standard-scales (according to [19])			
Positive-syndrome, mean item score (SD)	2.1 (0.7)		
Range	1.0–4.4		
Sum score (SD)	14.8 (5.0)		
Negative-syndrome, mean item score (SD)	2.3 (1.0)		
Range	1.0–5.1		
Sum score (SD)	16.1 (7.1)		
General score, mean item score (SD)	1.9 (0.4)		
Range	1.0–3.0		
Sum score (SD)	30.4 (7.1)		
Total score, mean item score (SD)	2.1 (0.5)		
Range	1.0–3.5		
Sum score (SD)	61.3 (14.4)		
First episode patients	47 (31.1%)		
Age at onset of illness (first psychotic sympt.) M (SD)	25.5 (7.9)		
Number of previous hospitalizations Md/M (SD)	2.0/3.1 (4.2)		
Duration of prev. hospitalizations (weeks) Md/M (SD)	10.0/32.2 (51.0)		
Neuroleptics (NL) at day of testing			
Patients treated with atypic NL only	57 (37.7%)		
Patients treated with standard NL only	55 (36.6%)		
Patients treated with combination	31 (20.5%)		
Patients without any NL	8 (5.3%)		
CPE at day of testing M (SD)	610 (364)		
Lifetime duration of neuroleptic treatment (months) M (SD)	48.5 (76.1)		
Patients with anticholinergic comedication	47 (31.1%)		

PANSS: Positive and Negative Syndrome Scale; CPE: Chlorpromazine-equivalents; Md: Median. [a]t-Test; [b]Fisher's exact test; [c]χ^2-test

indicating partial persistence of symptoms and sufficient variance for the purpose of this study. All patients except eight were treated with neuroleptic medication at the time of testing. Neuroleptics were prescribed according to clinical requirements. Dosage was transformed into chlorpromazine-equivalents (CPE). With regard to conventional antipsychotics, CPE were calculated according to Davis [5]. As regards atypical antipsychotics, transformations were done in line with Müller [30] and information of the pharmaceutical industry. The following potency factors were applied to the atypical substances: olanzapine 20.0, clozapine 2.0, risperidone 100.0, amisulprid 1.0, and sulpirid 0.5. Neuroleptic dosage had to be stable during the last 7 days before neuropsychological testing. However, in 27 cases the dosage had to be increased in order to improve the symptomatic status. Therefore we computed correlations between the increase of dosage and the neuropsychological factor scores, and a group comparison (dosage increases vs. stable dosage). As there were no significant correlations and no significant differences regarding cognitive performance, we did not exclude these 27 patients from further analyses. Approximately one-third of the patients received atypical neuroleptics only. Table 1 gives a summary of the variables of the neuroleptic medication.

Measures

Symptoms

To examine the inter-rater reliability of our PANSS ratings each of the two trained interviewers independently rated ten video-taped PANSS interviews. The following Intraclass-Correlation Coefficients (ICC) resulted for the PANSS standard scales: positive-syndrome $r_{ICC} = 0.91$, P (ICC) < 0.001; negative-syndrome $r_{ICC} = 0.85$, P (ICC) < 0.001; and general psychopathology $r_{ICC} = 0.86$, P (ICC) < 0.001.

Subjective experienced symptoms were assessed by the Symptom Checklist [SCL-90-R; 8]. The global severity index (GSI) was included in the analyses.

Neuropsychological testing

The following battery of tests was administered to assess neuropsychological functions that have been found to be impaired in schizophrenic patients: Computerized Wisconsin Card Sorting Test [WCST; 13]; Degraded Stimulus Continuous Performance

Table 2 Neuropsychological tests and raw scores/*z*-scores of the 151 patients with neuropsychological assessment

Test	Postulated neuropsychological function	Variables subjected to analyses	Mean raw score	SD raw score	Mean *z*-score	SD *z*-score
WCST [13]	Executive functioning: abstraction, concept formation, problem solving	Trials administered	110	21.62	−0.66	1.07
		% Perseverative errors	17.83	11.25	−0.96	1.76
		Categories completed	4.06	2.25	−1.29	1.91
		Failure to maintain set	0.97	1.08	−0.43	1.10
dsCPT[a] [32]	Vigilance	Sensitivity d′	2.35	1.04	−1.03	1.07
		Reaction time hits (in ms)	569.7	85.6	−2.16	1.66
AVLT [15]	Secondary verbal memory	Trial (T)1	4.96	1.88	−1.66	0.96
		T5	9.44	2.97	−3.83	1.97
		$\sum$ T1–5	37.55	10.93	−3.33	1.55
		T7 (delay)	6.8	3.46	−3.45	1.75
Trail Making Test [35]	Basic attention	Trail A (time in s)	41.95	20.73	−2.1	2.22
	Complex attention	Trail B (time in s)	105.5	65.18	−2.95	2.54
Digit-symbol (WAIS; 36)	Attention	Number correctly assigned symbols	41.78	11.72	−2.08	1.17
Digit span (WAIS; 36)	Immediate verbal memory	Forward	7.67	2.06	−0.21	1.01
	Working memory	Backward	5.44	2.19	−1.19	0.91
RCFT [27]	Delayed visual memory	Delayed recall	14.17	7.32	−1.52	1.30
Verbal fluency [17]	Processing speed	Number words	29.65	10.06	−1.11	1.26

[a] Data based on the dsCPT subgroup. WCST: Wisconsin Card Sorting Test, dsCPT: Degraded Stimulus Continuous Performance Test, AVLT: Rey Auditory-Verbal Learning Test, RCFT: Rey Complex Figure Test

Test [dsCPT; 32]; Trail Making Test A/B [TMT; 35]; Digit-Symbol and Digit-Span from the German version of the Wechsler Adult Intelligence Scale [WAIS; 36]; Rey Complex Figure Test, delayed recall [RCFT; 27]; Verbal Fluency, alphabetical version [17]; and the German version of the Rey Auditory Verbal Learning Test [AVLT; 15]. The AVLT includes multiple learning trials, interference techniques, and information recall after a delay interval of 30 min. This test allows the processes of data acquisition and recall to be subdivided into component parts. In accordance with Green et al. [11] we refer to these memory processes and components as secondary verbal memory. Table 2 gives an overview of the neuropsychological test battery along with the selected 17 variables, the neuropsychological functions, and the mean raw and *z*-scores.

The sequence of test application was always the same: (1) AVLT, (2) RCFT, (3) Verbal Fluency, (4) Digit-Symbol, (5) Digit Span, (6) TMT, (7) WCST, and (8) dsCPT. Since the implementation of the dsCPT was delayed due to measures of standardisation, 84 patients were available with complete data sets. Completion of the test battery took approximately 75–90 min.

The tests were applied by a trained psychological assistant with more than 10 years of experience in conducting psychological testing. The test application was supervised by a PhD level senior clinical psychologist.

Statistics

Factor analyses: we conducted principal components analyses (PCA), which was followed by orthogonal (Varimax) rotation. The number of meaningful factors to be retained for rotation was determined on the basis of the following criteria: (1) eigenvalues of factors to be retained are greater than 1, (2) the scree plot had to be compatible with the number of extracted factors, and (3) the factor solution had to allow a meaningful interpretation.

As measure of correlation we computed Kendall-tau-b. This correlation coefficient is more robust against violations of assumptions of distribution compared to Pearson-Correlation.

Multiple linear regressions were computed in an exploratory framework in order to analyse correlations between groups of independent variables with a dependent variable. These analyses were not designed as confirmative hypotheses tests.

The statistical influence of sociodemographic and anamnestic data on the correlation between neuropsychological and symptom scores was analysed using partial correlation. A relevant moderating variable should lead to a changed correlation coefficient between neuropsychological and symptom scores after controlling for their influence.

Results

Factor analysis of PANSS items

To group the 33 items of the PANSS into factor scores, 169 complete data sets (the full patient sample) were subjected to a factor analysis. At the initial step, our PCA extracted nine components, which accounted for 66% of variance. However, the scree plot was compatible only with a five-factor solution. Further, there was no meaningful interpretation of the nine factors. Thus, we now extracted five factors. Nevertheless, three variables reached small communalities ($h^2 < 0.3$), thus being barely represented by a five-factor model. Therefore, to prevent deceptive results, in the next step these three variables (Table 3) were excluded. We again extracted five components representing now altogether 54.5% of the variance. Communalities of the remaining 30 variables were satisfying up to excellent (Table 3). We interpreted the five factors as representing the following psychopathological dimensions. Factor 1 (18.5% of total variance): negative syndrome; factor 2 (15.4%): impulsiveness; factor 3 (7.6%): positive syndrome; factor 4 (6.7%): disorganization; and factor 5 (6.3%): depression (Table 3). Factor scores were created by summing up raw scores of items within each empirical domain (sum score) and dividing these sum scores by the number of items (mean item score). Figure 1 shows the box plots of the five psychopathological factors.

Table 3 Factor Analysis of the Positive and Negative Syndrome Scale (n = 169 complete data sets), rotated component matrix, five-factor solution, Principal Components Analysis, Varimax-Rotation, Kaiser-Normalization (factor loadings < 0.1 are not displayed)

No.	Item	h^2	1	2	3	4	5
P1	Delusions	0.730	−0.110		**0.835**		
P2	Conceptual Disorganization	0.584	−0.242	0.123	0.234	**0.681**	
P3	Hallucinatory behavior	0.440			**0.660**		
P4	Excitement[a]	0.521	−0.442	0.432		0.345	
P5	Grandiosity[b]	0.208	–	–	–	–	–
P6	Suspiciousness/persecution	0.557		0.189	0.719		0.163
P7	Hostility	0.502		**0.684**	0.187		
N1	Blunted affect	0.783	**0.845**	−0.186		0.158	
N2	Emotional withdrawal	0.723	**0.826**				0.172
N3	Poor rapport	0.686	**0.821**				−0.114
N4	Passive/apathetic social withdrawal	0.693	**0.819**				0.133
N5	Difficulty in abstract thinking	0.371	0.142		0.182	**0.599**	
N6	Lack of spontaneity and flow of conversation	0.685	**0.770**	−0.101		0.256	
N7	Stereotyped thinking	0.512	0.164	0.336	0.119	**0.593**	
G1	Somatic concern[b]	0.264	–	–	–	–	–
G2	Anxiety	0.520	0.179	0.194		0.126	**0.664**
G3	Guilt feelings	0.450		−0.148			**0.658**
G4	Tension[a]	0.360			0.183	0.353	0.444
G5	Mannerisms and posturing	0.351			−0.109	**0.562**	−0.131
G6	Depression	0.698	0.452	0.117	−0.129		**0.691**
G7	Motor retardation	0.531	**0.639**	−0.118	−0.178	0.233	0.184
G8	Uncooperativeness[a]	0.354		0.463	0.231		−0.278
G9	Unusual thought content	0.570		0.175	**0.715**	0.111	
G10	Disorientation[b]	0.147	–	–	–	–	–
G11	Poor attention	0.468		0.133	0.151	**0.595**	0.243
G12	Lack of judgment and insight	0.504			**0.561**	0.244	−0.395
G13	Disturbance of volition	0.474	0.324	−0.114		**0.601**	
G14	Poor impulse control	0.694		**0.821**		0.105	
G15	Preoccupation[a]	0.457	0.340	0.343	0.236	0.359	−0.167
G16	Active social avoidance	0.574	**0.693**		0.229		0.171
S1	Anger	0.630	**−0.108**	**0.786**			
S2	Difficulty in delaying gratification	0.358		**0.573**		0.125	0.134
S3	Affective lability	0.398	−0.127	**0.529**			0.283
Variance explained (total = 54.5%)			18.5	15.4	7.6	6.7	6.3

[a] Items with factor loadings <0.5 have not been included in the respective factor; [b] items with h^2 < 0.3 have been excluded from further analysis

Factor analysis of neuropsychological test scores

A total of 151 patients underwent the neuropsychological examination. The dsCPT data were available only for a subgroup of patients, leaving n = 84 complete data sets to be subjected to a factor analysis. The PCA extracted three components, which accounted for 59% of variance. Communalities of the 17 variables were satisfying (h^2 of at least 0.3) up to excellent (Table 4). We considered only loadings greater than or equal to 0.4 as substantial. The final resulting factor solution is shown in Table 4. We interpreted the three factors as representing the following constructs. Factor 1 (39.2% of total variance): memory; factor 2 (10.1%): attention; and factor 3 (9.6%): abstraction.

To calculate neuropsychological factor scores (function scores) raw test scores of all probands were first transformed to standard equivalents (z scores) using the means and standard deviations of the control group. All standard scores were computed so that higher values indicated better performance. Further, z scores were truncated at −6.0 to prevent rarely occurring, extremely deviant scores from distorting profile shape. Factor scores were created by averaging z scores within each empirical domain. For patients without dsCPT the attention factor has been computed without the respective two variables. This procedure was justified as an additional factor analysis resulted in the same variable–factor association without inclusion of the dsCPT variables. Finally, we computed a total score of cognitive impairment by averaging z scores of the three factor scores. By definition, the control group mean is represented by the zero line with SD = 1 for all domains. Figure 2 depicts the box plots of the three standardized factor scores and the total score of cognitive impairment.

Correlation of symptoms and cognitive impairments

Table 5 shows the correlations between the cognitive factor scores on the one hand and the PANSS factor scores, the single items of the disorganization factor, and the Global Severity index of the Symptom Checklist (SCL-GSI) on the other hand. With regard to PANSS factors and disorganization items as well as the SCL-GSI higher values indicate a more pronounced symptom severity. With regard to standardized cognitive factors, higher values indicate

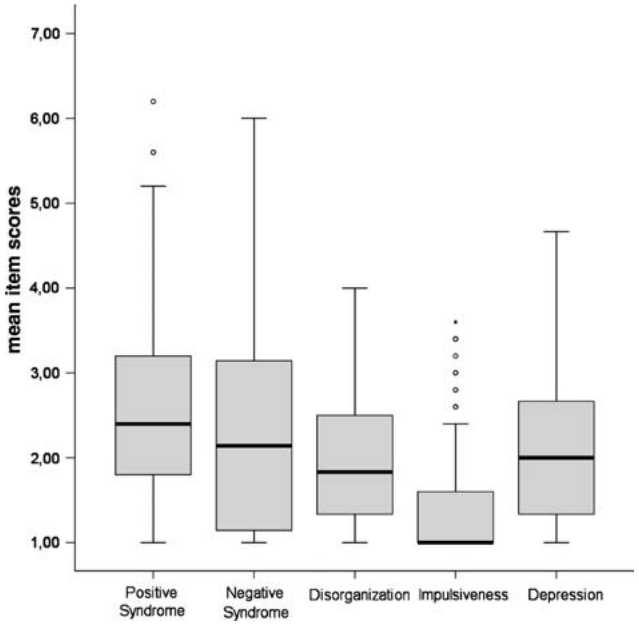

Fig. 1 Distribution of symptom factors: mean item scores of the five-factor solution (n = 169 patients). Mean item scores represent the factor score in the dimension of single items. The boxplots indicate median, quartiles, ranges, outliers, and extreme values

better performance. Thus, negative and significant correlation coefficients reflect an association of more pronounced symptom severity with worse cognitive performance.

There is no correlation between cognitive impairment and the positive syndrome, disorganization, and impulsiveness. Deficits in memory and attention show a significant and negative correlation with the negative syndrome and depression. Total cognitive impairment (total score) is significantly and negatively associated only with the negative syndrome. Even the statistically significant correlation coefficients reflect only a weak association (≤0.20).

In addition, we analysed the items of the PANSS disorganization factor (P2, N5, N7, G5, G11, and G13). Here we found weak but significant correlations between "difficulty in abstract thinking" (PANSS, N5) and the cognitive factor-scores memory, attention, and total cognitive impairment (total score). These significant correlation coefficients are consistently negative. The other correlations were smaller and not significant. In particular, contrary to expectation, there was no significant correlation between "difficulty in abstract thinking" (PANSS, N5) and the cognitive factor-score "abstraction". Further, no significant correlation resulted between "poor attention" (PANSS, G11) and the cognitive factor-score "attention". Regarding self-rated symptoms (SCL-GSI) we found negative and significant correlations (all coefficients ≤0.20) with memory, abstraction, and total cognitive impairment.

In order to analyse whether the lack of correlation in the previous analyses is due to the use of factor scores we analysed the correlation of neuropsychological test raw scores as presented in Table 4 and the PANSS disorganization items by using multiple linear regression analyses. The items P2 ("conceptual disorganization") and G5 ("mannerisms and posturing") were not predicted by any neuropsychological variable. Item N5 ("difficulty in abstract thinking") was predicted significantly only by the TMT-B (P = 0.002). Item N7 ("stereotyped thinking") was predicted by WCST-failure to maintain set (P < 0.001) and digit-span forward (P = 0.050). Item G11 ("poor attention") was predicted by WCST-failure to maintain set (P = 0.006) and AVLT $\sum$ 1–5 (P = 0.017). Finally, Item G13 ("disturbance of volition") was predicted by WCST-number categories completed (P = 0.002) and WCST-percent perseverative errors (P = 0.029).

Analysis of moderating factors

We computed the partial correlation coefficients between the cognitive and the symptom factors after controlling for sex, age, education, diagnostic subtype, first vs. multiple episode, age at first admission,

Table 4 Factor Analysis of the neuropsychological test scores (n = 84 complete data sets): Rotated component matrix, three-factor solution, Principal Components Analysis, Varimax-Rotation, Kaiser-Normalization (factor loadings <0.1 are not displayed)

Item	h^2	1	2	3
WCST—number trials administered	0.849	−0.151	−0.247	**−0.875**
WCST—% perseverative errors	0.575	−0.271	−0.364	**−0.607**
WCST—categories completed	0.771	0.294	0.327	**0.760**
WCST—failure to maintain set	0.440		0.263	**−0.607**
RCFT—delayed recall	0.542	**0.703**	0.170	0.141
AVLT—trial 1	0.603	**0.756**	0.165	
AVLT—trial 5	0.787	**0.814**	0.240	0.260
AVLT—$\sum$ trials 1 to 5	0.870	**0.867**	0.249	0.237
AVLT—trial 7	0.785	**0.876**	0.125	
TMT A	0.579	−0.436	**−0.620**	
TMT B	0.535	−0.362	**−0.505**	−0.385
Verbal fluency	0.550	0.243	**0.699**	
Digit span forward	0.293	0.165	**0.468**	0.217
Digit span backward	0.302	0.152	**0.424**	0.315
Digit symbol test	0.642	0.391	**0.671**	0.195
dsCPT—d′	0.347	0.156	**0.546**	0.159
dsCPT—reaction time hits	0.538	0.193	**−0.648**	0.283
Variance explained (total = 58.9%)		39.2%	10.1%	9.6%

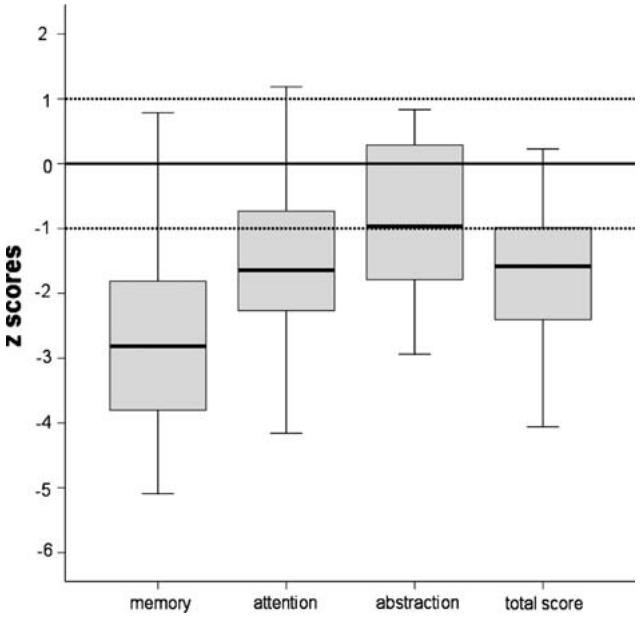

Fig. 2 Distribution of cognitive functioning: standardized factor scores (attention, memory, abstraction) and the total score of cognitive functioning in $n = 151$ patients. The boxplots indicate median, quartiles, and ranges. The horizontal lines indicate mean (solid line) and SD (broken line) of $n = 40$ matched, normal controls

number and duration of previous admissions, duration of neuroleptic treatment, treatment with or without standard neuroleptics, neuroleptic dosage, and adjunctive anticholinergic treatment. We found that even after controlling for these variables there was no significant correlation between the PANSS disorganization factor and cognitive factor scores ($r = -0.090$ to 0.026; $P = 0.329$ to 0.998)

Discussion

As in previous studies we found evidence for a five-factor solution of the PANSS including a disorganization or cognitive factor. However, compared to Liddle's initial conceptualisation of disorganization the factor disorganization based on PANSS ratings remains different. Inappropriate affect is not represented adequately in the PANSS. Disturbance of volition as well as mannerisms are included in this factor and therefore broaden the concept of disorganization. The resulting factor solution explains 55% of the variance. This is less than Lykouras et al. [25, explained variance of 59.9%] and Mass et al. [26, explained variance of 72%] reported but comparable with Lindenmayer et al. [24].

Regarding neuropsychological assessment we found a three-factor solution including attention, abstraction, and memory. However, the attention factor represents a variety of cognitive processes and includes vigilance as well as divided attention, working memory, and verbal fluency. This is in line with Albus et al. [2]. As in our study they found TMT and Digit Symbol to load on the same factor. In addition, a factor analysis of Friis et al. [9] resulted in a 'working memory' factor including verbal fluency, digit span, and CPT-hits. Thus, the result of our factor analysis supports the hypothesis of a global impairment of attention capacity rather than of more specific deficits of vigilance, selective attention, or psychomotor speed. Moreover, Mohamed et al. [28] emphasized that cognitive impairment in schizophrenia is a generalized deficit 'that is not easily explained by a single anatomical region or ability area. The profile of test and factor scores in our study (Table 2) supports this conclusion.

The major result of this paper is that we did not find a significant correlation between disorganization as assessed by PANSS ratings and any neuropsychological factor score. Surprisingly, symptom ratings of attention (PANSS, G11) and abstraction (PANSS, N5) on the one hand and neuropsychological measures of attention and abstraction on the other hand do not share a substantial amount of variance in our study.

Bell et al. [4] found moderate correlations only when using a more direct measure of thought dis-

Table 5 Psychopathological syndromes and cognitive factors ($n = 151$)—Kendall-tau-b

	Memory	Attention	Abstraction	Total score
PANSS-factors				
Positive syndrome	0.050	0.020	0.010	0.046
Negative syndrome	−0.114*	−0.159**	−0.048	−0.119*
Disorganization	0.020	−0.070	0.006	0.011
Impulsiveness	0.072	0.037	0.049	0.081
Depression	−0.123*	−0.117*	−0.019	−0.104
Disorganization items				
Conceptual disorganization (P2)	0.107	0.035	0.063	0.103
Difficulty in abstract thinking (N5)	−0.132*	−0.204**	−0.123	−0.161*
Stereotyped thinking (N7)	0.025	−0.114	−0.064	−0.037
Mannerisms and posturing (G5)	0.058	0.037	0.026	0.051
Poor attention (G11)	−0.034	−0.041	0.001	−0.004
Disturbance of volition (G13)	0.019	−0.003	0.100	0.056
Self-rated symptoms				
SCL-GSI[a]	−0.133*	−0.094	−0.132*	−0.142*

* $P < 0.05$; ** $P < 0.01$; (two-sided test)

[a] Correlation analyses based on $n = 135$ completed SCL-R questionnaires

order (Gorham Proverb Test) that is similar to the rating of thought disorder of the PANSS. Even the highest correlation of 0.4 between a classical neuropsychological test (WCST) and PANSS disorganization [4] indicate only 16% shared variance. The conclusion of these authors that 'the cognitive component of the PANSS is a valid measure of cognitive deficits in schizophrenia' does not find substantiation in our results. O'Leary et al. [33] stated that the hypothesis of an association between disorganized symptoms and cognitive dysfunction is supported by a significant correlation of 0.27 at the highest. In our view such an interpretation should not only be based on the significance but also on the strength of the correlation. A shared variance of less than 10% is not convincing when taking the conceptual overlap of cognitive dysfunction and disorganization into account. Whether significant or not, it is surprising to find that a clinical interview addressing attention and a test of attention do not correlate to a higher degree.

This lack of correlation cannot be attributed to the computing of a disorganization factor score. Even if single symptoms of our disorganization factor are analysed separately (see Table 5) there are only few correlations, which are limited to neuropsychologically assessed attention. In addition, our explorative regression analyses show only weak correlations between single symptoms and single test scores. We found a significant association between 'lack of attention' (PANSS-G11) and 'failure to maintain set' (WCST) and the 'number of reproduced words' (AVLT—total number of reproduced words) respectively after controlling for the other test scores. One could speculate that some form of distractibility or difficulty to focus attention over more than a few seconds is observable in a clinical interview as well as by test scores. Similarly, the significant partial correlation between 'difficulty in abstract thinking' (PANSS-N5) and the Trail Making Test B could indicate a problem of cognitive flexibility that can be observed in an interview and a test. However, as the shared variance between interview based symptom rating and neuropsychological test is clearly limited to less than 10% it is obvious that symptom rating and tests assess mainly different aspects of the patients' pathology.

The correlation between disorganization and cognitive tests is not moderated by sociodemographic or anamnestic variables. Even after controlling for these potential confounders no higher correlation emerges. This is true for sex, age, education, diagnostic subtype, first vs. multiple episode, age at first admission, number and duration of previous admissions, duration of neuroleptic treatment, treatment with or without standard neuroleptics, neuroleptic dosage, and adjunctive anticholinergic treatment. Thus, we could not identify a subgroup showing a significant correlation between disorganization and cognitive impairment. Comparable results were found by Moritz et al. [29] and Albus et al. [1].

Another consideration relates to the test battery. Would other tests have led to a more substantial association between disorganization and cognitive impairment? Baxter and Liddle [3] found that disorganization was associated with the Stroop Test and stated that suppressing irrelevant verbal responses could be the specific deficit underlying disorganization. On the other hand, the correlation did not exceed 0.37 and is comparable to correlation coefficients regarding single tests in our test battery. In addition, given the strong association between different tests, it is in our view reasonable to rely on factorized scores and not on parameters of single tests in order to control for the intercorrelations between tests.

Thus, it does not seem plausible that the lack of association between disorganization and cognitive deficits depends on the specific operationalization of both disorganization and cognitive testing or on the influence of demographic or anamnestic confounders. In addition, the results of Hughes et al. [18] are in line with the hypothesis of independence between measures of cognitive impairment and symptoms. They found that improvements in symptoms did not produce an improvement in cognitive impairment. Patients show change in both areas, but change was not correlated.

Finally the limitations of this study should be taken into account. We cross-sectionally examined medicated inpatients in the beginning stabilization phase. Different results could possibly have been obtained in the acute phase and with neuroleptic naïve patients. In remitting illness the association of symptoms and cognitive dysfunctions could be more complex compared to acute illness [3]. In addition, we investigated patients with their first episode as well as multi-episode patients. It cannot be ruled out that the factor structure of symptoms or cognitive impairment is changing between different phases of the disorder. However, the number of previous episodes did not show a moderating influence on the correlation of disorganization and cognitive impairment. To sum up, with respect to research about cognition in schizophrenia it should be carefully differentiated between the different sources of information. In particular when addressing the underlying neurobiological pathology one has to be aware of the large amount of unexplained variance between clinical interviews and tests. Cognitive dysfunction and disorganization are heterogeneous concepts that have to be defined and operationalized in detail in order to allow meaningful interpretation.

In clinical practice comprehensive neuropsychological assessment is not replaceable by interviewing the patient. Our data provide evidence that a rating of disorganization in clinical interview and neuropsychological testing assess different aspects of the schizophrenic disorder.

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