Available online at www.sciencedirect.com

SCIENCE DIRECT®

Comprehensive Psychiatry 47 (2006) 7–19

Comprehensive PSYCHIATRY

www.elsevier.com/locate/comppsych

Executive dysfunction, self, and ego pathology in schizophrenia: an exploratory study of neuropsychology and personality

Heinz Boeker[a,*], Matthias Kleiser[b], Doerte Lehman[b], Lutz Jaenke[c], Bernhard Bogerts[b], Georg Northoff[b]

[a]*Department of Psychiatry, University of Zurich, CH-8032 Zurich, Switzerland*
[b]*Department of Psychiatry, University of Magdeburg, D-39120 Magdeburg, Germany*
[c]*Department of Psychology, University of Magdeburg, D-39120 Magdeburg, Germany*

Abstract

Schizophrenic patients show a variety of symptoms, including positive and negative symptoms and ego pathology. Their exact underlying neuropsychological mechanisms as well as related changes in personality, however, remain unclear. We therefore conducted an exploratory study to investigate the relationship among neuropsychological functions, various dimensions in personality, and the different kinds of psychopathological symptoms.

We investigated 22 paranoid schizophrenic patients and 22 age- and sex-matched healthy controls using a battery of neuropsychological, personality, and psychopathological tests and scales. Neuropsychological tests included executive function, working memory, and episodic memory, whereas personality assessment relied on the Temperament and Character Inventory by Cloninger (*Arch Gen Psychiatry*. 1987;44:573-88). Psychopathological rating included the scales for the assessment of positive and negative symptoms and the Ego Pathology Inventory by Scharfetter (*Psychol Med*. 1981;11(2):273-80).

Schizophrenic patients showed significant deficits in executive function, working memory, and episodic memory. In contrast to healthy subjects, no significant correlation between working memory and executive function was observed in schizophrenic patients. Instead, both working memory and executive dysfunction were rather related to deficits in retrieval of episodic memory. Positive and negative symptoms correlated with episodic memory deficits but not with any dimension of the personality, whereas ego pathology, in contrast, correlated with executive dysfunction and working memory deficits. Moreover, schizophrenic patients showed specific changes in the self-dimensions of their personality, which correlated significantly with both executive dysfunction and ego pathology.

Schizophrenic patients show deficits in working memory and executive function as well as functional dissociation between both. In contrast to positive and negative symptoms, ego pathology in these patients is specifically related to executive dysfunction and alterations in the self-dimension of their personality. It can therefore be concluded that ego pathology must be distinguished from positive and negative symptoms in both underlying neuropsychological dysfunction and predisposing changes in personality.

1. Introduction

Patients with schizophrenia present various combinations of symptoms that can be divided into different categories. These include positive symptoms such as delusions and hallucinations, negative symptoms such as blunted affect and psychomotor poverty, disorganization with thought disorders, and ego pathology with depersonalization, derealization, and so on [1-3]. The exact neuropsychological mechanisms underlying these different kinds of symptoms remain unclear. Although deficits in working memory and executive function have been reported in several studies [4-9], the exact relationship between these neuropsychological deficits and the different kinds of psychopathological symptoms has not yet been elucidated. One could, for example, imagine that positive and negative symptoms and ego pathology might be subserved by alterations in distinct neuropsychological functions. However, studies focusing on the neuropsycho-

* Corresponding author. Privatdozent of Psychiatry, Psychiatric University Hospital, University of Zurich, CH-8029 Zurich 8, Switzerland. Tel.: +41 1 384 2608; fax: +41 1 383 4456.
E-mail address: boeker@bli.unizh.ch (H. Boeker).

0010-440X/$ – see front matter © 2005 Elsevier Inc. All rights reserved.
doi:10.1016/j.comppsych.2005.04.003

logical mechanisms underlying ego pathology have not yet been reported.

Ego pathology includes symptoms that are often described as Schneider first-rank symptoms or passivity phenomena [3,10,11]. These symptoms are often subsumed under psychotic or positive symptoms [12] or bizarre delusions [13]. As a result, ego pathology is often not clearly distinguished from delusions and hallucinations. In contrast, Scharfetter [14] subsumes these symptoms under the heading of "ego pathology" for which he developed a special scale, the Ego Pathology Inventory (EPI) (see Methods for further description). Frith et al [11] suggest a neuropsychological deficit in "self-monitoring," which may account for this kind of symptoms (see also References [15,16]). However, the relation between self-monitoring and other neuropsychological deficits remains unclear. Because self-monitoring involves both executive function and online monitoring (ie, working memory), one may assume a close relationship between ego pathology on the one hand and working memory and executive function on the other.

In addition to the underlying neuropsychological mechanisms of ego pathology in schizophrenic patients, the predispositional traits in their personality to develop these kinds of symptoms remain unclear. For example, certain personality dimensions, which are closely related with the experience and awareness of the own "self," may predispose for the development of ego pathology as "self-disturbances." However, no investigation of the self and the personality in schizophrenic patients with ego pathology has been reported so far. Cloninger [17] developed a scale for the assessment of the personality, the Temperament and Character Inventory (TCI), which includes 2 dimensions concerning especially the self (see Methods for further description). One may therefore assume a close relationship between ego pathology and alteration in the "self-dimension" of their personality, which, in turn, may be related in some way with deficits in working memory and executive function.

To account for underlying neuropsychological mechanisms and predisposing personality traits in ego pathology, we conducted an exploratory study. Paranoid schizophrenic patients with ego pathology were investigated using a neuropsychological test battery that included executive function and working memory. Their personality traits were accounted for by the TCI. Ego psychopathology and positive and negative symptoms were measured with the EPI and the scale for the assessment of positive and negative symptoms, respectively. The focus in the present study was therefore put on (1) distinction between ego pathology and positive and negative symptoms with regard to executive function and working memory; (2) specific relationship between ego pathology and alterations in the self-dimension of the personality; and (3) differential relationship between neuropsychological measures and personality traits in ego pathology and positive and negative symptoms.

2. Methods

2.1. Subjects

We investigated 22 schizophrenic patients (12 women, 10 men; age, 29.7 ± 4.5 years). They were selected from all admitted inpatients at the Psychiatric University Clinic in Magdeburg between December 1998 and October 2000 and participated voluntarily after signing an informed consent form. The study was approved by the local ethics committee. Each patient was required to have a minimum education of 8 years (mean, 11.2 ± 1.3 years). They fulfilled *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* [18] criteria (made by a semistructured clinical interview) for paranoid schizophrenia (n = 22), as determined by consensus of the current treating psychiatrist and 2 senior psychiatrists. Their mean duration of illness was 9.0 ± 4.1 years, their mean duration of hospitalization was 38.7 ± 69.4 weeks), and their mean number of hospitalizations was 3.9 ± 1.8 times.

All patients had to show some ego pathology on admission, which was screened for by Schneider first-rank symptoms [19] and the passivity phenomena scale [10]. Patients had to show at least 4 signs of Schneider first-rank symptoms (5.1 ± 1.2) and at least 5 signs from the scale for passivity phenomena (6.3 ± 1.7). Symptoms were assessed and rated by 2 experienced and trained psychiatrists (DL and GN) who rated the same patient within 1 hour (interrater reliabilities with r = 0.85-0.96).

Patients with a history of traumatic brain injuries, epilepsy, electroconvulsive therapy, alcohol or substance abuse, or other diagnosable neurological and/or physical conditions were excluded from the study. All patients had been receiving atypical neuroleptics (risperidone, n = 4; olanzapine, n = 5; clozapine, n = 13) for a mean duration of 4.5 ± 2.3 years. However, 8 patients stopped taking their medication, leading to the present relapse, so that in these patients, the same neuroleptic medication was given again. In the other 14 patients, neuroleptic medication was reduced by the ambulatory psychiatrist, so that on admission, medication was increased. All patients had an equivalent of clozapine dose of 924.1 ± 218.6 mg on the day of testing. Patients treated with antidepressants, benzodiazepines, anticholinergics, or lithium were excluded. Consequently, on the day (day 21) of testing, all patients received only an atypical neuroleptic.

The comparison group consisted of 22 age- and sex-matched healthy subjects (12 women, 10 men; age, 27.9 ± 2.8 years) with a mean education of 11.8 ± 1.1 years. The groups did not differ significantly in age, education, or sex. Subjects with a history of or with first-degree relatives with psychiatric illness, neurological or physical illness, traumatic brain injury, or alcohol or substance abuse were excluded.

2.2. Psychopathology

General psychopathological assessments were made using the Global Assessment Scale [20] (day 0, 14.9 ± 3.6; day 21, 45.7 ± 5.6).

Positive and negative symptoms were assessed with the Positive and Negative Symptom Scale [21] (day 0, 85.3 ± 19.4; day 21, 46.7 ± 11.2).

Affective psychopathology was assessed with the Hamilton Depression Scale [22] (day 0, 15.6 ± 5.4; day 21, 9.5 ± 3.6) and the Hamilton Anxiety Scale [23] (day 0, 22.5 ± 4.5; day 21, 11.3 ± 4.9).

Detailed and quantitative assessment of ego pathology was made with the EPI by Scharfetter [24] (day 0, 75.7 ± 10.5; day 21, 43.3 ± 11.7).

The EPI reliably measures ego pathology and related behavior [24,25] and has already been used quite successfully for measurement of psychological effects of *S*-ketamine on ego function [26]. The EPI yields a global score and subscales measuring "ego identity," "ego demarcation," "ego consistency," "ego activity," "ego vitality," "hypercompensation," "body control," "thought disorder," and "motor reactions." The ego identity subscale includes changes or loss of one's own identity in respect to "gestalt," physiognomy, sex, and biography. Ego demarcation refers to one's uncertainty or inability to differentiate between ego and non-ego spheres concerning thought process, affective state, and body experience. The ego consistency subscale comprises the dissolution, splitting, and destruction in experiencing a coherent self, body, thought process, chain of feelings, and a structured external world. Ego activity refers to the deficit in one's own ability or power for self-determined acting, thinking, feeling, and perceiving. The ego vitality subscale includes the experience or fear of one's own death, of the fading away of vitality, or of ruin of humankind or of the universe. The hypercompensation subscale includes items for supernatural influences on other persons and the world. The body control subscale includes items for perception and meaning of one's own body. The thought disorder subscale includes items for experience of control and incoherence of one's own thoughts. The motor reaction subscale includes items for control and perception of movements.

2.3. Neuropsychology

General intelligence was assessed with the Multiple Vocabulary Test B [*Mehrfachwahl-Wortschatz-Intelligenztest*, MWT-B] [27], measuring verbal-dependent intelligence; the Standard Progressive Matrices (SPM) [28], measuring verbal-independent intelligence; and subtest 3 from the Performance System [*Leistungsprüfsystem 3*] by Horn [29].

Attentional abilities were assessed with the d2 Attention Test [30], measuring "attention to details" for which the total score (d2 TS) and the total score minus the mistakes (d2 TSM) were determined. Moreover, the Color-Word Interference (CWI) Test [31], including all 3 parts, Words (FWL-T), Colors (NOM-T), and Word-Color Interference (SEL-T), was applied. In addition, we applied some tests from the battery for attention [32], which included measures for divided attention (dual-task performance with visual signals and auditory signals), go/no-go test (inhibition of predisposed reaction), (inter)modal comparison (comparison between auditory and visual signal with regard to correspondence or noncorrespondence), and attention shift (ie, alternation between 2 classes of verbal signs).

Executive functions were assessed by the Trail-Making Test (TMT) [33], based on a German version of the A-test of the TMT, the *Zahlenverbindungstest*; Verbal Fluency 1 and 2, based on the subtests 5 and 6 of the battery by Horn [29]; the Tower of London (TOL) test [34]; and the 2-Group Test according to Kramer [35], which, similar to the Wisconsin Card Sorting Test, requires sorting and ordering of cards according to different categories, thereby measuring the ability for conceptualization, categorization, and abstraction.

Working memory was assessed with the Working Memory Test from the Battery for Attention [32], consisting of a 2-back task with numbers; Digit Span from Wechsler Memory Scale (WMS), assumed to measure the verbal-phonological subsystem of working memory by using a forward and backward condition; and Visual Memory Span from WMS, assumed to measure the visual-spatial, that is, nonverbal subsystem of working memory using a forward and backward condition.

Semantic memory and episodic memory were assessed with the Verbal Associates I and II from WMS [36], measuring encoding and retrieval of semantic information (ie, word pairs), and the Logical Memory Tests I and II from WMS, measuring encoding and free early and late retrieval of episodic information from 2 stories with 25 units of information, respectively.

Autobiographical memory was assessed with the Autobiographical Memory Inventory (AMI) [37]. The AMI includes 2 major components, 1 part for personally experienced events (autobiographical events) and 1 part for semantic information concerning the own person (autobiographical facts). With regard to time, the AMI is divided into 3 parts (youth, young adulthood, and recent events). Raw values can be obtained for both components as well as for all 3 parts across time.

2.4. Personality

Personality was assessed with the TCI [38], which was developed on the basis of a psychobiological model of personality [17,39]. The term *temperament* refers to automatic emotional reactions to subjective experience that may be genetically predisposed and therefore stable across time. Four dimensions of temperament are distinguished: novelty seeking (NS), harm avoidance (HA), reward dependence (RD), and persistence (PS), which are assumed to be related to distinct transmitter systems (dopamine, serotonin, and noradrenaline). The term *character* refers to concepts of the own person (ie, the self), thereby focusing on individual differences in intentions, decisions, and values. Three distinct dimensions in the character section are distinguished: self-directedness (SD), cooperativity (CO), and self-transcendence (ST).

The TCI is a self-assessment scale that consists of 240 items with 2 possible answers, either yes or no, to the various questions. All dimensions, except PS, have 3 to 5 lower-order subscales. NS reflects a tendency toward *exploratory excitability* (NS 1) in response to novelty, *impulsiveness* (NS 2) in decision making, *extravagance* (NS 3) in approach to cues of reward, and *disorderliness* (NS 4) with quick loss of temper. HA reflects a tendency to respond intensely to aversive stimuli and involves *anticipatory anxiety* (HA 1) about possible problems, *fear of uncertainty* (HA 2), *shyness with strangers* (HA 3), and consequent easy *fatigability* (HA 4). RD reveals a tendency

Table 1
Results from neuropsychological investigation in healthy and schizophrenic subjects

	Schizophrenic subjects (n = 22)		Healthy subjects (n = 22)		*t* Test (corrected)		
	Mean	Standard deviation	Mean	Standard deviation	*df*	t	*P*
Attention							
d2 Test TS	448.9	97.9	517.9	57.1	42	2.02	.057
d2 Test TSM	403.2	88.7	499.1	62.1	42	2.94	.008*
Color-word							
FWL-T	31.4	4.3	29.6	3.9	42	−1.15	.266
NOM-T	44.8	6.0	42.2	6.0	42	−0.90	.380
SEL-T	78.9	9.1	67.8	8.6	42	−2.67	.170
Attention shift							
Time (ms)	1071.8	328.7	786.3	158.5	42	−3.34	.003*
Rate of mistakes	6.8	8.2	3.6	4.6	42	−1.47	.152
Correct	84.2	14.5	90.0	8.7	42	1.48	.148
Go/no-go							
Time (ms)	587.7	70.7	558.4	78.7	42	−0.98	.338
Rate of mistakes	0.33	0.49	0.23	0.44	42	−0.55	.587
Correct	23.6	0.8	23.6	0.5	42	0.12	.900
Modal comparison							
Time (ms)	512.4	111.5	456.2	91.4	42	−1.67	.098
Rate of mistakes	1.26	2.73	0.84	1.71	42	−0.57	.572
No answers	0.47	0.90	0.42	1.02	42	−0.17	.867
Divided attention							
Time (ms)	760.9	89.5	696.4	52.9	42	−2.69	.010*
Rate of mistakes	2.5	3.69	0.53	0.84	42	−2.07	.060
No answers	3.0	2.03	0.95	1.22	42	−3.75	.001*
Working memory							
2-Back Number							
Time (ms)	804.2	209.4	641.1	191.5	42	−2.58	.014**
Rate of mistakes	8.2	3.3	1.7	2.3	42	−2.96	.003*
No answers	3.2	2.9	1.1	1.3	42	−2.73	.010*
Digit Span							
Global score	18.8	3.5	20.8	2.0	42	1.87	.026**
Forward score	10.7	1.3	11.4	0.8	42	1.12	.058
Backward score	8.1	2.4	9.5	1.8	42	−2.21	.040**
Visual Memory	18.8	3.7	20.1	2.7	42	−0.97	.191
Forward score	11.6	1.8	11.8	1.7	42	−1.31	.666
Backward score	7.0	2.3	8.5	2.0	42	−2.27	.023**
Semantic and episodic memory							
Semantic							
Verbal Paired Associates I	20.5	1.9	22.4	1.5	42	−3.24	.003*
Verbal Paired Associates II	7.6	0.5	7.8	0.4	42	−1.89	.257
Episodic							
Logical Memory I	20.8	5.1	24.6	5.0	42	−2.31	.038**
Logical Memory II	15.1	4.0	19.9	3.1	42	−3.79	.001*
Executive functions							
VF1	19.8	6.1	27.5	5.6	42	−3.76	.001*
VF2	31.9	8.9	41.5	5.2	42	−3.77	.001*
Two-group test	2.4	0.7	3.6	0.7	42	−3.70	.005*
TMT	88.8	18.8	68.8	12.6	42	−3.06	.006*
TOL	10.1	3.2	9.1	2.9	42	−0.53	.495

Note the significant differences between schizophrenic and healthy subjects in working memory, executive function, and semantic and episodic memory, whereas there were no general differences in attentional abilities. FWL-T indicates Time for reading; NOM-T, Ability of nomination; SEL-T, Ability of interference; VF1, Verbal Fluency 1; VF2, Verbal Fluency 2.

* $P < .01$ (corrected).

** $P < .05$ (corrected).

to respond intensely to reward and includes *sentimentality* (RD 1), social *attachment* (RD 2), and *dependence* (RD 3) upon approval of others. PS reflects a tendency to industriousness, ambitious overachieving, and perseverance despite frustration. SD refers to the ability to control, regulate, and adapt one's behavior in accordance with chosen goals and values. It includes the subdimensions *responsibility* (SD 1), *purpose awareness* (SD 2), *mental flexibility* (SD 3), *self-acceptance* (SD 4), and *self-congruence* (SD 5). Cooperativeness reveals an inclination toward social tolerance, empathy, helpfulness, and compassion. It includes *social tolerance* (CO 1), *empathy* (CO 2), *compassion* (CO 3), and *helpfulness* (CO 4). ST reflects a tendency toward spirituality and identification with the wider world, as well as the ability to accept ambiguity and uncertainty. It includes the subdimensions *patience* with ambiguity and uncertainty (ST 1), *creativity and spiritual acceptance* (ST 2), and *unity and identification with wider universe* (ST 3).

2.5. Procedure

All patients were tested on day 21 (duration, ~1.5 hours) after admission (no neuropsychological investigation on day 0 or before day 21 because patients were too ill at these early time points) by a trained psychologist (MK) who was entirely independent from and blind to clinical and psychopathological evaluation. Patients were selected independently by GN and DL. Quality control procedures included double scoring of all test data and periodic review regarding reliability of test administration and scoring. To avoid early exhaustion and/or monotony and to provide alternations between tests with and without time limits, the tests were administered in the following order: SPM, Horn 3, attention from *Testbatterie zur Aufmerksamkeitsprüfung*, MWT-B, Verbal Fluency 1 and 2, 2-Group Test by Kramer, TMT, TOL, CWI, Logical Memory I, Digit Span, Visual Memory Span, Logical Memory II, Verbal Paired Associates I, 2-back number Working Memory, and Verbal Paired Associates II. After a break of 2 hours, the TCI was administered.

2.6. Statistical analyses

The 2 groups were compared regarding demographic data (age, education, etc) using 2-tailed *t* tests.

Neuropsychological test differences between both groups were tested using 2-tailed *t* tests with Bonferroni correction for multiple comparisons.

Correlations among demographic, psychopathological, neuropsychological, and personality variables were calculated using Pearson product-moment correlation analyses. To reduce the number of variables to be correlated, we performed correlation analyses only between those variables that differed significantly in *t* tests between schizophrenic and healthy subjects. Furthermore, we calculated partial correlations to control for effects of age, illness duration, and neuroleptic medication on those variables for which the initial correlations were significant. Partial correlations were considered as significant at $P < .05$ (2-tailed). Only those relationships that correlated significantly in both kinds of correlation analyses were considered as relevant and are mentioned in the Results.

3. Results

3.1. General and demographic data

There were no differences between healthy and schizophrenic subjects in age and other demographic data. Furthermore, there were no differences (healthy/schizophrenic) in the measures of general intelligence (MWT-B, 31.4 ± 2.4/29.2 ± 3.2; SPM, 27.5 ± 1.7/25.8 ± 2.9; *Leistungsprüfsystem 3*, 27.6 ± 4.5/32.2 ± 5.7), which, in addition, did not differ from the norm values in the different tests. Furthermore, neuropsychological and personality scores were not found to correlate significantly with neuroleptic dosage, as measured in chlorpromazine equivalents.

3.2. Neuropsychological measures

3.2.1. Executive functions

There were highly significant differences between both groups in executive functions, Verbal Fluency 1 and 2, TMT,

Statistical results from comparison between schizophrenic and healthy subjects in the Autobiographical Memory Inventory (AMI)

	Autobiogr. events		Autobiogr. facts	
	F	p	F	p
Group	16,75	,000	42,17	,000
Time period	4,14	,021	14,52	,000
Group x Time	3,62	,034	10,78	,000

Graphic illustration of performance in the Autobiographical Memory Inventory (AMI) in schizophrenic (■) und healthy (●) subjects

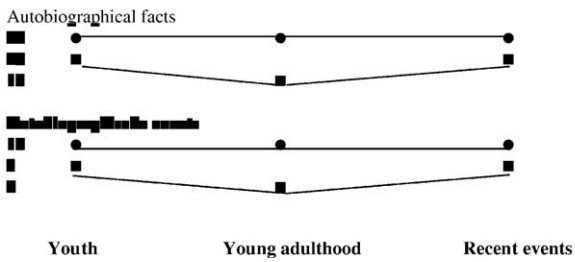

Fig. 1. Autobiographical memory in schizophrenic and healthy subjects. Autobiographical memory was investigated with the AMI, which focuses on facts and events in 3 different periods (youth, young adulthood, and recent events) in the life of a person. One-factorial analysis of variance was calculated to compare both dimensions (period, event/facts) between groups. The table shows the results from statistical analysis, whereas the figure presents a graphic illustration of the scores in the AMI. Note the difference between schizophrenic and healthy subjects in young adulthood with respect to both autobiographical events and facts, whereas no differences between both groups were observed in the other periods (youth and recent events).

and the 2-Group Test according to Kramer (see Table 1). Only in the TOL test were no significant differences between groups obtained.

In summary, schizophrenic patients showed major deficits in executive functions particularly in those tasks that require a high level of conceptualization, abstraction, and categorization.

3.2.2. Working memory

Schizophrenic patients showed significant deficits in all 3 working memory tasks, both verbally and visually. The significant deficits predominantly concerned the backward component that requires a higher degree of online monitoring and thus abilities in working memory than the forward component (see Table 1).

In summary, schizophrenic patients showed major deficits in working memory.

3.2.3. Semantic and episodic memory

Schizophrenic patients showed a significant deficit in Verbal Associates I (encoding of semantic information) and Logical Memory II (retrieval of episodic information), whereas in Verbal Associates II and Logical Memory I, neither group differed from the other.

Table 2
Significant correlations among working memory, executive function, and episodic memory in healthy (n = 22) and schizophrenic (n = 22) subjects

Working memory	Executive functions			Episodic memory	
	TGTK[a]	VF1	VF2[b]	LME	LMR
DSG	0.649*/–	–/–	–/–	–/–	–/0.488**
DSF	0.469**/–	–/–	–/–	–/–	–/0.584*
DSB	0.523*/–	–/–	–/–	–/–	–/0.381**
VSG	–/–	–/–	–/–	–/–	–/0.369**
VSF	–/–	–/–	–/–	–/–	–/–
VSB	–/–	–/–	–/–	–/–	–/0.434**

Data are presented as r values for healthy subjects/schizophrenic subjects. Note the opposite pattern of correlations in healthy and schizophrenic subjects. Healthy subjects show a significant relationship between working memory and executive function, which remains absent in schizophrenic patients. Schizophrenic subjects, in contrast, show a significant relationship between working memory and retrieval of episodic memory, which remains absent in healthy subjects. Moreover, as footnoted, these patients show significant correlations between tests of executive functions and those for episodic memory, which remain absent in healthy subjects. The r value from correlation is 0.678. TGTK indicates 2-Group Test by Kramer; VF1, Verbal Fluency 1; VF2, Verbal Fluency 2; LME, logical memory encoding; LMR, logical memory retrieval; DSG, Digit Span Global score; DSF, Digit Span Forward score; DSB, Digit Span Backward score; VSG, Visual Working Memory Span Global score; VSF, Visual Working Memory Span Forward score; VSB, Visual Working Memory Span Backward score.

[a] Significant correlation ($r = 0.385$, $P < .05$) between TGTK and LME in schizophrenic patients, which remained absent in healthy controls.

[b] Significant correlation between VF2 and LME ($r = 0.505$, $P < .01$) and LMR ($r = 0.371$, $P < .05$) in schizophrenic patients, which remained absent in healthy controls.

* $P < .01$.

** $P < .05$.

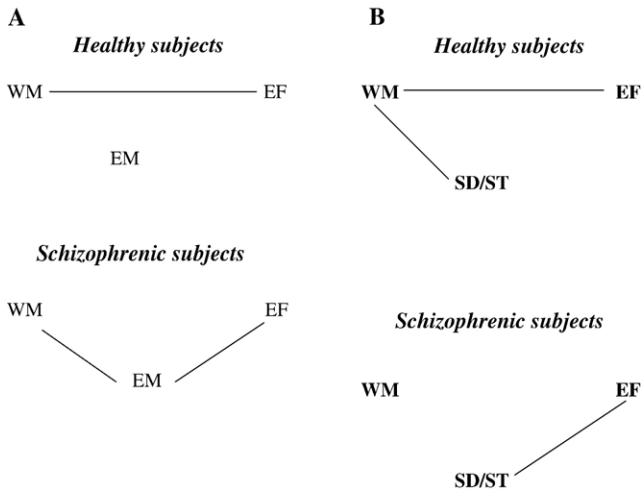

Fig. 2. Graphic illustration of the relationship between neuropsychological functions and the self-dimensions of the personality in healthy and schizophrenic subjects. The lines indicate significant correlations ($P < .05$), whereas their absence indicates no significant relationship. For further details, see Tables 2 and 4. Note the opposite pattern of relationships in healthy and schizophrenic subjects. A, Healthy subjects show a relationship between executive function and working memory, which remains absent in schizophrenic subjects. They, in contrast, show a relationship of both working memory and executive function with episodic memory, which remains absent in healthy controls. B, An analogous pattern of opposite relationship can be observed with respect to the self-dimension of the personality. In healthy subjects, working memory is related with the self-dimensions, whereas in schizophrenic patients, executive functions correlate significantly with the self-dimensions. WM indicates working memory; EF, executive function; EM, episodic memory.

In summary, schizophrenic patients show deficits in encoding semantic information and retrieval of episodic information.

3.2.4. Autobiographical memory

Statistical comparison with a 1-factorial analysis of variance between schizophrenic and healthy subjects with regard to autobiographical events and facts across all 3 periods (see Methods) showed significant results for group, time, and group-by-time interaction in both autobiographical events and facts ($P < .01$) (see Fig. 1). In addition, post hoc t tests were calculated for all 3 periods. Schizophrenic patients differed significantly from healthy subjects only in the period "young adulthood" for both autobiographical events and facts ($P < .0001$), whereas the 2 remaining periods (youth, recent events) showed significant differences between groups neither in autobiographical events nor in autobiographical facts (see Fig. 1).

In summary, schizophrenic patients show clear deficits in autobiographical memory concerning both events and facts, which, however, is restricted to one particular period in their life (ie, young adulthood).

3.2.5. Attentional abilities

No significant differences between schizophrenic and healthy subjects were found in the CWI with its 3 subtests

(FWL-T, NOM-T, SEL-T), go/no-go test, and (inter)modal comparison (see Table 1). In the tests divided attention, attention shift, and the d2 TSM, significant differences between both groups were found (see Table 1). However, the overall pattern rather suggested no major attention deficits in schizophrenic patients. In summary, schizophrenic patients showed no major and generalized deficits in attention.

In summary, neuropsychological investigation revealed major deficits in executive functions, working memory, autobiographical memory, and semantic and episodic memory in schizophrenic patients.

3.3. Intercorrelations between neuropsychological measures

In healthy subjects, there was a significant positive correlation between executive function (ie, 2-Group Test by Kramer) on the one hand and working memory (ie, Digit Span with Global, Forward, and Backward scores) on the other, whereas no significant correlations between working memory/executive functions and episodic memory were obtained (see Table 2 and Fig. 2A). Schizophrenic patients, in contrast, showed no significant correlation between executive functions and working memory (see Table 2 and Fig. 2A). However, they showed a significant positive correlation between working memory tasks (Digit Span with Global, Forward, and Backward scores and Visual Memory Span with Global and Backward scores) and retrieval of episodic information (ie, Logical Memory II) (see Table 2). Furthermore, executive tests (Verbal Fluency and 2-Group Test by Kramer) showed significant correlations with Logical Memory I and II (r = 0.371-0.505, $P < .05$).

In summary, healthy and schizophrenic subjects show an opposite pattern in the relationship among executive functions, working memory, and episodic memory. Healthy subjects show a significant relationship between executive functions and working memory, whereas there is no relationship between working memory/executive functions and episodic memory. In contrast, schizophrenic patients can be characterized by a significant relationship between working memory/executive functions and episodic memory, whereas a relationship between working memory and executive functions cannot be found.

Table 3
Results in scales and subscales from the TCI in schizophrenic (n = 22) and healthy (n = 22) subjects

	Schizophrenic subjects		Healthy subjects		t Test, P (corrected)	Norm values	
	Mean	Standard deviation	Mean	Standard deviation		Mean	Standard deviation
NS	19.81	5.48	20.23	6.11	ns	19.40	5.50
NS 1	6.36	1.96	6.95	2.06	ns	6.50	2.10
NS 2	4.36	2.23	4.36	1.94	ns	4.10	2.10
NS 3	5.45	1.71	5.23	2.09	ns	5.10	2.10
NS 4	3.63	1.70	3.68	1.89	ns	3.70	1.80
HA	21.00	5.28	18.09	5.71	ns	15.30	6.20
HA 1	5.77	2.40	4.50	1.97	<.05	4.40	2.20
HA 2	5.40	1.22	5.10	1.54	ns	4.50	1.80
HA 3	4.86	2.21	4.64	1.59	ns	3.60	2.10
HA 4	4.95	2.29	3.86	2.38	ns	2.90	2.20
RD	16.54	2.19	16.14	3.12	ns	15.50	3.60
RD 1	7.04	1.78	6.59	2.19	ns	6.30	2.10
RD 2	5.50	1.79	5.73	2.05	ns	5.70	1.90
RD 3	4.00	1.07	3.82	1.05	ns	3.50	1.40
PS	3.72	1.31	4.09	1.71	ns	4.10	1.70
SD	28.00	8.50	33.91	4.78	<.01	33.20	6.40
SD 1	4.64	2.01	6.91	0.97	<.001	6.10	1.70
SD 2	6.36	1.59	6.05	1.29	ns	6.30	1.60
SD 3	2.82	1.53	4.05	1.36	<.01	4.10	1.30
SD 4	7.73	3.38	7.36	2.52	ns	7.60	2.50
SD 5	6.45	2.99	9.55	1.95	<.001	9.20	2.10
CO	30.91	4.22	33.68	3.30	<.05	32.20	5.00
CO 1	6.36	1.65	7.09	0.97	ns	6.90	1.30
CO 2	4.18	1.44	5.54	1.01	<.001	5.10	1.30
CO 3	5.73	1.10	6.05	0.95	ns	6.00	1.30
CO 4	8.18	1.84	8.18	1.87	ns	7.70	2.20
CO 5	6.45	1.87	6.82	1.30	ns	6.50	1.50
ST	14.41	7.78	10.32	5.95	<.05	11.60	5.40
ST 1	5.64	2.60	2.86	1.81	<.001	4.30	2.30
ST 2	3.27	1.58	2.27	1.69	<.05	3.20	1.80
ST 3	5.50	4.10	5.18	3.77	ns	4.10	2.90

Note the significant differences in the self-dimensions between healthy and schizophrenic subjects. Schizophrenic subjects showed significantly lower scores in SD and significantly higher scores in ST. ns indicates not significant ($P > .05$).

3.4. Personality

The main differences between schizophrenic and healthy subjects were found in the character part of the TCI, whereas in the temperament part, almost no significant differences were obtained (see Table 3). The main differences within the character part were obtained in the dimensions SD and ST where both global scores and various subdimensions revealed significant differences. In SD, the subdimensions responsibility (SD 1), mental flexibility (SD 3), and self-congruence (SD 5) revealed significantly lower values in schizophrenic patients when compared with healthy controls (and norm values). In ST, the subdimensions patience (ST 1) and creativity (ST 2) showed significantly higher values in schizophrenic patients as compared with healthy controls (and norm values). Moreover, the CO dimension of the character showed significant differences between schizophrenic and healthy subjects (see Table 3).

In summary, schizophrenic patients showed alterations in those dimensions of the personality that concerned their self.

Table 4
Significant correlations among working memory, executive function, and the dimensions of the self in healthy and schizophrenic subjects

Self-directedness, working memory, and executive function

	SD					
	SD G	SD 1	SD 2	SD 3	SD 4	SD 5
Working memory						
DSG	–/–	–/–	–/–	–/–	0.436*/–	0.410*/–
DSF	–/–	–/–	–/–	–/–	–/–	–/–
DSB	–/–	–/–	–/–	–/–	–/–	0.369*/–
VSG	0.376*/–	–/–	0.380*/–	–/–	0.606**–	–/–
VSF	–/–	0.366*/–	–/–	–/–	0.499*/–	–/–
VSB	0.369*/–	–/–	–/–	–/–	0.428*/–	–/–
Executive function						
TGTK	–/–	–/0.381*	–/0.370*	–/–	–/0.377*	–/–
TOL	–/–	–/–	–/–	–/0.382*	–/–	–/–

Self-transcendence, working memory, and executive function

	ST			
	ST G	ST 1	ST 2	ST 3
Working memory				
DSG	–/–	–/–	−0.421*/–	–/–
DSF	–/–	–/–		–/–
DSB	–/–	–/–	−0.396*/–	–/–
VSG	–/–	–/–	–/–	–/–
VSF	–/–	–/–	–/–	–/–
VSB	–/–	–/–	–/–	–/–
Executive function				
TGTK	–/–	–/–	–/–	–/–
TOL	–/−0.640**	–/−0.753**	–/−0.573**	–/−0.580**

Data are presented as r values for healthy subjects/schizophrenic subjects. Note the opposite pattern of correlations in healthy and schizophrenic subjects. Healthy subjects show significant correlations between working memory and dimensions of the self in personality, whereas this relationship remains absent in schizophrenic patients. Schizophrenic subjects, in contrast, show significant correlations of executive functions with the dimensions of the self, which remain absent in healthy subjects. Moreover, note the differential direction of correlation in SD and ST. SD shows positive correlations, whereas ST can be characterized by negative correlations. The lower SD, the worse neuropsychological function and the higher ST, the lower neuropsychological scores. The r value from correlation is 0.678. SD G indicates SD Global score; SD 1, Responsibility subscale; SD 2, Purpose Awareness subscale; SD 3, Mental Flexibility subscale; SD 4, Self-Acceptance subscale; SD 5, Self-Congruence subscale; ST G, ST Global score; ST 1, Ambiguity and Uncertainty subscale; ST 2, Creativity and Spiritual Acceptance subscale; ST 3, Unity and Identification With Wider Universe subscale; DSG, Digit Span Global score; DSF, Digit Span Forward score; DSB, Digit Span Backward score; VSG, Visual Working Memory Span Global score; VSF, Visual Working Memory Span Forward score; VSB, Visual Working Memory Span Backward score; TGTK, 2-Group Test by Kramer; TOL, Tower of London.

* $P < .05$.

** $P < .01$.

Table 5
Significant correlations between neuropsychology and psychopathology in schizophrenic patients (n = 22)

	Positive and negative symptoms		Ego pathology (EPI)			
	SAPS	SANS	GS	EI	HC	BC
Working memory						
DSG	–	–	−0.371*	−0.366*	−0.405*	−0.362*
DSF	–	–	–	−0.410*	−0.464*	–
DSB	–	–	–	–	–	−0.448*
VSG	–	–	–	–	–	−0.369*
VSF	–	–	–	–	–	−0.372*
VSB	–	–	–	–	–	–
Executive function						
TGTK	–	–	–	–	−0.374*	–
TOL	–	–	−0.386*	–	−0.467*	–
Episodic memory						
LME	–	–	–	–	–	–
LMR	−0.488*	−0.405*	–	–	–	–

Note the differential pattern of correlations between psychopathological symptoms and neuropsychological measures. Positive and negative symptoms correlate negatively with episodic memory (retrieval in particular), whereas ego pathology correlates rather negatively with working memory and executive functions. The higher both kinds of symptoms, the lower the scores in the respective neuropsychological test. The r value from correlation is 0.678. SAPS indicates Scale for the Assessment of Positive Symptoms; SANS, Scale for the Assessment of Negative Symptoms; GS, Global score; EI, Ego Identity subscale; HC, Hypercompensation subscale; BC, Body Control subscale; DSG, Digit Span Global score; DSF, Digit Span Forward score; DSB, Digit Span Backward score; VSG, Visual Working Memory Span Global score; VSF, Visual Working Memory Span Forward score; VSB, Visual Working Memory Span Backward score. TGTK, 2-Group Test by Kramer; TOL, Tower of London; LME, logical memory encoding; LMR, logical memory retrieval.

* $P < .05$.

3.5. Correlation between neuropsychology and personality

Healthy subjects show significant correlations between working memory and dimensions of the self in personality, whereas there are no correlations of the latter with executive functions (see Table 4 and Fig. 2B). Schizophrenic subjects, in contrast, show significant correlations of the self-dimensions with executive functions, whereas, in contrast to healthy subjects, there is no relationship of the latter with working memory (see Table 4 and Fig. 2B). Moreover, both self-dimensions (ie, SD and ST) could be distinguished from

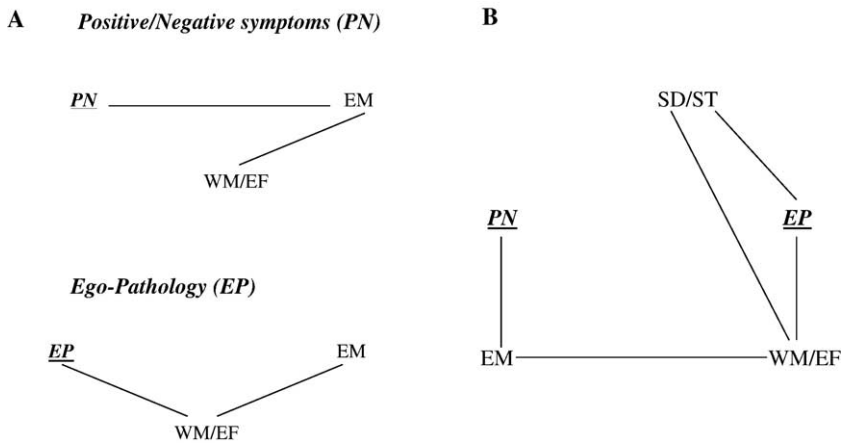

Fig. 3. Graphic illustration of the relationship among neuropsychological functions, the self-dimension of the personality, and psychopathology. The lines indicate significant correlations ($P < .05$), whereas their absence indicates no significant relationship. For further details, see Tables 5 and 6. Note the opposite pattern of positive and negative symptoms and ego pathology. A, Positive and negative symptoms correlate with episodic memory but not with working memory/executive function. B, Ego pathology correlates with working memory and executive function but not with episodic memory. Moreover, ego pathology is related with the self-dimensions of the personality as in contrast to positive and negative symptoms that correlate with neither dimensions of the personality. PN indicates positive and negative symptoms; EP, ego pathology; WM, working memory; EF, executive function; EM, episodic memory.

each other with regard to the direction of the correlation in both groups. SD correlated positively with working memory or executive function, whereas ST correlated negatively. No other dimensions of the TCI showed any significant relationships with neuropsychological measures in either healthy or schizophrenic subjects.

In summary, healthy and schizophrenic subjects showed an opposite pattern in the relationship among working memory, executive functions, and self-dimensions of the personality. Healthy subjects show a relationship of their self with working memory, whereas the schizophrenic self seems to be associated rather with executive functions.

3.6. Correlation between personality/neuropsychology and psychopathology

3.6.1. Neuropsychology and psychopathology

Positive and negative symptoms in schizophrenic patients, as measured with the scales for the assessment of positive and negative symptoms, correlated significantly negatively with results from episodic memory and retrieval in particular (Logical Memory II), whereas no correlations of these symptoms with either working memory or executive functions were found (see Table 5 and Fig. 3A and B). Ego pathology, in contrast, correlated significantly negatively

Table 6
Significant correlations between the self-dimensions of the personality and ego psychopathology in schizophrenic patients (n = 22)

Personality (TCI)	Ego pathology (EPI)									
	GS	EI	ED	EC	EA	EV	HC	BC	TD	MR
SD										
SD G	–	–	–	−0.382*	–	–	–	–	–	–
SD 1	–	−0.365*	–	–	–	–	–	–	–	–
SD 2	–	–	–	–	–	–	–	–	–	–
SD 3	–	–	–	–	–	−0.488*	–	–	–	–
SD 4	−0.380*	−0.549**	−0.398*	−0.476*	–	–	−0.510**	–	−0.497**	−0.473*
SD 5	–	–	–	–	–	–	–	−0.428*	–	–
ST										
ST G	–	–	0.392*	–	0.416*	–	–	–	–	–
ST 1	–	–	0.429*	–	–	–	–	–	–	–
ST 2	–	–	0.387*	–	0.374*	–	–	–	–	–
ST 3	–	–	0.370*	–	0.403*	–	–	–	–	–

Note the differential pattern of correlations of SD and ST. SD correlates with various dimensions of ego pathology, whereas ST correlates only with ego demarcation and ego activity. The other dimensions of the TCI did not correlate at all with ego pathology. Note the different direction of correlations in SD and ST. SD correlates negatively with ego pathology, the lower SD, the more ego pathology. In contrast, ST correlates positively with ego pathology, the higher ST, the more ego pathology. The r value from correlation is 0.678. GS indicates Global score; EI, Ego Identity subscale; ED, Ego Demarcation subscale; EC, Ego Consistency subscale; EV, ego vitality subscale; HC, Hypercompensation subscale; BC, Body Control subscale; TD, Thought Disorder subscale; MR, Motor Reaction subscale.

* $P < .05$.

** $P < .01$.

with scores from executive functions and working memory tests, whereas no correlations with episodic memory or other tests were obtained (see Table 5 and Fig. 3A and B).

In summary, positive and negative symptoms and ego pathology show a differential pattern of correlation with neuropsychological measures, the former being related to episodic memory and the latter rather to executive functions/working memory.

3.6.2. Personality and psychopathology

Positive and negative symptoms did not show any significant correlations with either dimension in the TCI (ie, the personality). Ego pathology, in contrast, showed significant correlations with particular dimensions in the TCI and the self-dimensions (SD and ST), whereas it did not correlate with any other dimension in the TCI (see Table 6 and Fig. 3B). SD correlated negatively with various dimensions in ego pathology, whereas ST correlated positively with ego demarcation and ego activity in ego pathology (see Table 6 and Fig. 3B). In addition to the EPI, significant correlations between anxiety (Hamilton Anxiety Scale) and the self-dimensions (SD total, SD 2, and SD 4; $r = -0.367$, -0.370, and -0.383, respectively) were obtained. The less SD, the more anxiety.

In summary, ego pathology is related with the self-dimensions of the personality, whereas there is no relationship between positive and negative symptoms and particular personality traits.

Finally, we found no significant correlations between positive and negative symptoms and ego pathology. Accordingly, there seems to be no relationship between the 2 types of symptoms.

In summary, positive and negative symptoms and ego pathology show differential relationships with both neuropsychological measures and personality.

4. Discussion

We investigated the relationship among neuropsychology, personality, and psychopathology in schizophrenic patients in an exploratory study and obtained the following main findings:

1. significant deficits in executive functions, working memory, and episodic/autobiographical memory in schizophrenia;
2. significant alterations in the self-dimension of the personality in schizophrenia;
3. opposite patterns in the relationship among working memory, executive functions, and episodic memory in schizophrenic and healthy subjects;
4. differential patterns in relationships of positive and negative symptoms and ego pathology with working memory/executive functions, episodic memory, and the self-dimensions of the personality.

4.1. Relation among executive function, working memory, and episodic memory in schizophrenia

Schizophrenic patients showed significant deficits in both executive functions and working memory. This is in full accordance with results from other studies that reported similar deficits [4-9]. The present findings extend these results by demonstrating a different relationship between both functions. Healthy controls showed a significant correlation between working memory and executive function that could not be found in schizophrenia.

Working memory requires online monitoring and manipulation of information, whereas executive function reflects conceptualization, abstraction, and categorization. Executive function probably presupposes online monitoring and manipulation and thus working memory. This is reflected in the significant correlations we found between executive functions and working memory tests in healthy subjects. This correlation was absent in schizophrenic patients, which indicates that they remain apparently unable to relate the 2 functions with each other. Therefore, conceptualization, abstraction, and categorization (ie, executive function) may no longer rely on online monitoring and manipulation of information (ie, working memory) in these patients. One may therefore speak of functional dissociation between working memory and executive function in schizophrenia.

Because of both deficits in and functional dissociation between working memory and executive function, schizophrenic patients may no longer be able to experience and monitor a coherent self, which Frith et al [11] call “self-monitoring.” This ability for self-monitoring seems to be particularly deficient in patients with passivity phenomena and delusions of alien controls that reflect ego pathology [15,16]. Accordingly, our results are in accordance with the hypothesis of a deficit in self-monitoring as suggested by Frith et al [11].

Similar to other studies [4,6,8,40-43], we found not only deficits in working memory and executive function but, in addition, deficits in semantic and episodic memory. Moreover, confirming the results from a recent study [39], we obtained deficits in autobiographical memory specifically in young adulthood. Extending the results of these studies, we found that the deficit in retrieval of episodic memory correlated significantly with deficits in both working memory and executive function in schizophrenia. In contrast, healthy controls showed neither a relationship between executive function and episodic memory nor between working memory and episodic memory.

Schizophrenic patients may therefore be characterized by a different pattern in the relationship among executive function, working memory, and episodic memory, as compared with healthy subjects. They may compensate for the functional dissociation between executive function and working memory (as discussed previously) by relying strongly on episodic memory retrieval. However, it remains

unclear whether the deficit in episodic memory retrieval is the effect of the abnormal relationship with executive function/working memory or whether it is the cause of the latter. Accordingly, further studies focusing on the relationship between these different neuropsychological functions in both healthy and schizophrenic subjects are necessary.

Moreover, executive function and working memory on the one hand and retrieval of episodic memory on the other were related to distinct kinds of psychopathological symptoms. Both positive and negative symptoms correlated with the deficits in the retrieval of episodic memory, whereas the ego pathology was rather related with the deficits in working memory and executive function. Although previous studies demonstrated deficits in executive function and working memory in schizophrenia, they nevertheless could not relate these neuropsychological deficits with specific psychopathological symptoms [7]. The present study shows that alterations in the ego (ie, ego pathology) may be specifically related with deficits in executive function and working memory. Positive and negative symptoms, in contrast, were rather associated with deficits in episodic memory retrieval. Previous studies may have missed this relationship because they often do not account for ego pathology as distinguished from positive and negative symptoms.

The assumption of a relationship between working memory/executive function and ego pathology is further supported by consideration of the potentially underlying neuroanatomical substrates. Both working memory and executive function have been shown to be related to prefrontal cortical function [44]. Moreover, the functional dissociation between executive function and working memory may reflect disturbances in functional connectivity within the prefrontal cortex.

Ego pathology, as induced by the *N*-methyl-D-aspartate antagonist ketamine in healthy subjects, correlated significantly with metabolic activity in the prefrontal cortex [25]. Because there have been no functional imaging studies focusing on ego pathology in schizophrenia, our results lend indirect support to the assumption of a close relationship between prefrontal cortical function and ego pathology. Positive and negative symptoms may rather be related to frontotemporal function [45,46], as may be reflected in their significant correlation with episodic memory. However, further studies are necessary to determine the exact relationship between ego pathology and prefrontal cortical function. The results of the present, rather exploratory study may nevertheless be considered as a starting point for the generation of a more detailed psychophysiological hypothesis of ego pathology in schizophrenia.

4.2. Relation between personality and neuropsychology in schizophrenia

Schizophrenic patients showed significant alterations in the character of their personality, especially concerning the dimensions of the self (ie, SD and ST). Although they showed decreased scores in SD, schizophrenic patients could be characterized by increased ST. Our findings in the TCI are in accordance with those obtained by Guillem et al [47]. Similar to our results, they found decreased scores in SD (and CO) and increased values for ST in schizophrenic patients. Based on the low values in SD, one may assume a lack of an internal organizational principle, rendering these patients unable to define, set, and pursue meaningful goals. Moreover, the high ST scores may reflect a high tolerance for ambiguity and a tendency toward magical thinking and dissolution of the self within the world. Contrary to the present study, Guillem et al [47] found alterations in the temperament dimensions too. This difference may be accounted for by differences in the patient sample. Whereas our study included young patients with multiple episodes of paranoid schizophrenia, the study of Guillem et al [47] apparently included patients with chronic or residual schizophrenia.

Extending the results from their study, we found a significant relationship between ego pathology and changes in the self-dimensions. Guillem et al [47] found psychotic symptoms and bizarre delusions to be significantly correlated with SD and ST. Psychotic symptoms and bizarre delusions include both positive symptoms and many of the symptoms generally regarded as ego pathology [12,13]. Because only ego pathology correlated with ST and SD, the present results strongly suggest a distinction between positive symptoms and ego pathology.

Moreover, because of the different relation of SD and ST with ego pathology, one may assume involvement of different aspects of the self in ego pathology. On the one hand, ego pathology reflects deficits in the ability to control and regulate the own self, which may account for the decrease in SD. This could be mirrored in our finding of a negative correlation between ego pathology and SD, that is, the lower the scores in SD, the more ego pathology. On the other hand, ego pathology reflects the blurring and transcendence of the boundaries between the own self and the world, which may account for the increase in ST. This may be mirrored in our finding of a positive correlation between ego pathology and ST, that is, the higher the scores in ST, the more ego pathology. Accordingly, both dimensions of the self (ie, SD and ST) may reflect distinct although complementary aspects of ego pathology.

Interestingly, schizophrenic patients showed a different pattern of relationships between SD/ST and executive function/working memory. SD and ST correlated significantly with working memory in healthy subjects, whereas in schizophrenic patients, both dimensions were rather related with executive function. The healthy self may thus strongly rely on working memory, that is, online monitoring and manipulation of the incoming information. Because of the lack of relationship with working memory, “normal” self-monitoring may remain impossible in schizophrenic patients who, instead, rely on executive function. This may ultimately lead to ego pathology, an assumption that is supported by our finding of a significant correlation between executive

function/working memory and ego pathology. Therefore, our results indeed provide indirect evidence for the hypothesis of Frith et al [11] of a close relationship between deficits in self-monitoring and ego pathology.

4.3. Methodological limitations

First, we did not apply tests especially designed for self-monitoring as, for example, is the case in the studies by Frith et al [11,15,16]. Therefore, the assumption of a direct relationship between the deficit in working memory (ie, online monitoring) on the one hand and self-monitoring on the other remains speculative. Our results may therefore be considered as exploratory and thus as a starting point for further neuropsychological exploration of the process of self-monitoring.

Secondly, it should be considered that our patient sample showed some peculiarities. Our patient sample consisted predominantly of young patients who, nevertheless, already had multiple episodes of paranoid schizophrenia with ego pathology (see Methods). Because they had multiple episodes, their planning abilities and thus their executive function may have already adapted [6]. This may, for example, account for the absence of deficits in the TOL task (see also Reference [9] for a similar finding).

Third, it is worth mentioning that the term *executive dysfunction* should be differentiated in further detail. Schizophrenic patients did not show deficits in all executive functions. Deficits occurred predominantly in those tasks that require strong abstraction, categorization, and conceptualization as reflected in the 2-Group Test by Kramer. In contrast, other executive functions such as inhibition (go/no-go task) showed no abnormalities.

References

[1] Bleuler E. Dementia praecox oder die Gruppe der Schizophrenien. In: Aschaffenburg G, editor. Handbuch der Psychiatrie. Spezieller Teil 4. Abt. 1. Hälfte. Leipzig: Franz Deuticke; 1911. p. 1-420.

[2] Kraepelin E. Dementia praecox and paraphrenia. Edinburgh: Livingstone; 1913.

[3] Klosterkötter J. Die Entwicklung der schizophrenen Symptome ersten Ranges. Fundam Psychiatr 1992;6:81-94.

[4] Bilder RM, Goldman RS, Robinson D, Reiter G, Bell L, Bates JA, et al. Neuropsychology of first-episode schizophrenia: initial characterization and clinical correlates. Am J Psychiatry 2000;157(4):549-59.

[5] Duffy L, O'Carroll R. Memory impairment in schizophrenia—a comparison with that observed in the alcoholic Korsakoff syndrome. Psychol Med 1994;24:155-65.

[6] Hutton SB, Puri BK, Duncan LJ, Robbins W, Barnes TRE, Joyce EM. Executive function in first-episode schizophrenia. Psychol Med 1998; 28:463-73.

[7] Kuperberg G, Heckers S. Schizophrenia and cognitive function. Curr Opin Neurobiol 2000;10:205-10.

[8] Mellers JD, Toone BK, Lishman WA. A neuropsychological comparison of schizophrenia and schizophrenia-like psychosis of epilepsy. Psychol Med 2000;30(2):325-35.

[9] Pantelis C, Barnes TRE, Nelson HE, Tanner S, Weatherley L, Owen AM, et al. Frontal-striatal cognitive deficits in patients with chronic schizophrenia. Brain 1997;120:1823-43.

[10] Spence SA, Brooks DJ, Hirsch SR, Liddle PF, Meehan J, Grasby PM. A PET study of voluntary movement in schizophrenic patients experiencing passivity phenomena (delusion of alien control). Brain 1997;120:1997-2011.

[11] Frith C, Rees G, Friston K. Psychosis and the experience of self. Brain systems underlying self-monitoring. Ann N Y Acad Sci 1998;843: 170-8.

[12] Andreasen NC, Arndt S, Alliger R, Miller D, Flaum M. Symptoms of schizophrenia. Methods, meanings and mechanisms. Arch Gen Psychiatry 1995;52:341-51.

[13] Toomey R, Kremen W, Simpson J, Samson J, Seidman LJ, Lyons M, et al. Revisiting the factor structure for positive and negative symptoms: evidence from a large heterogenous group of psychiatric patients. Am J Psychiatry 1997;154:371-7.

[14] Scharfetter C. Allgemeine psychopathologie. Stuttgart: Georg Thieme Verlag; 1991.

[15] Mlakar J, Frith CD. Central monitoring deficiency and schizophrenic symptoms. Psychol Med 1994;24:557-64.

[16] Stirling JD, Hellewell JS, Quraishi N. Self-monitoring dysfunction and the schizophrenic symptoms of alien control. Psychol Med 1998; 28(3):675-83.

[17] Cloninger RC. A systematic method for clinical description and classification of personality variants. Arch Gen Psychiatry 1987; 44:573-88.

[18] American Psychiatric Association. DSM-IV: Diagnostic and Statistical Manual of Mental Disorders. 4th ed. Washington, DC: APA; 1994.

[19] Schneider K. Primäre und sekundäre Symptome bei Schizophrenie. Fortschr Neurol Psychiatr 1957;9:487-90.

[20] Endicott J, Spitzer R, Flies J, Maier M. The Global Assessment Scale. Arch Gen Psychiatry 1976;33:766-71.

[21] Andreasen NC, Marneros A. Positive und negative symptomatik der schizophrenie. Nervenarzt 1992;63:262-70.

[22] Hamilton M. A rating scale for depression. J Neurol Neurosurg Psychiatry 1960;23:56-62.

[23] Hamilton M. The assessment of anxiety states by rating. Br J Med Psychol 1959;32:50-5.

[24] Scharfetter C. Ego-psychopathology: the concept and its empirical evaluation. Psychol Med 1981;11(2):273-80.

[25] Hauser R, Scharfetter C. On the prognostic relevance of ego-psychopathology in schizophrenia: a 2.5-year follow-up. Eur Arch Psychiatr Neurol Sci 1990;239(5):293-302.

[26] Vollenweider F, Leenders K, Oye I, Hell D, Angst J. Differential psychopathology and patterns of cerebral glucose utilization produced by *S*- and *R*-ketamine in healthy volunteers in PET. Eur Neuropsychopharmacol 1997;7:25-38.

[27] Lehrl S. Mehrfachwahl-Wortschatz-Intelligenztest. MWT-B. Balingen: PERIMED-spitta; 1995.

[28] Raven J. Manual for Raven's progressive matrices. London: HK Lewis; 1976.

[29] Horn L. LPS: Leistungsprüfsystem. Göttingen: Hogrefe Verlag; 1965.

[30] Brickenkamp R. Test d2. Aufmerksamkeits-Belastungs-Test. Göttingen: Hogrefe Verlag; 1994.

[31] Bäumler G. Farbe-Wort-Interferenztest nach J.R.Stroop (FWIT). Göttingen: Hogrefe Verlag; 1985.

[32] Zimmermann P, Fimm B. Testbatterie zur Aufmerksamkeitsprüfung (TAP). Herzogenrath: PSYTEST; 1994.

[33] Oswald WD, Roth E. ZVT: Zahlenverbindungstest. Göttingen: Hogrefe Verlag; 1987.

[34] Shallice T. Specific impairments in planning. Philos Trans R Soc Lond 1982;298:199-209.

[35] Goldstein K, Scheerer M. Abstract and concrete behavior: an experimental study with special tests. Psychol Monogr 1941;53:2.

[36] Wechsler D. WMS-R: Wechsler Memory Scale—revised. Manual. San Antonio (Tex): Psychological Corporation/Harcourt Brace Jovanovich; 1987.

[37] Kopelman MD, Wilson BA, Baddeley AD. Autobiographical Memory Inventory. Bury St Edmunds: Thames Valley Test Company; 1990.

[38] Cloninger RC, Przybeck TR, Svrakic DM, Wetzel RD. Das Temperament- und Charakter-Inventar (TCI). Manual. Frankfurt: Swets & Zeitlinger; 1999.
[39] Cloninger RC, Svrakic NM. Psychobiological model of personality. Neurosci News 1998;1:40-6.
[40] Feinstein A, Goldberg TE, Nowlin B, Weinberger DR. Types and characteristics of remote memory impairment in schizophrenia. Schizophr Res 1998;30:155-63.
[41] McKenna PJ, Mortimer AM, Hodges JR. Semantic memory and schizophrenia. In: David AS, Cutting JC, editors. The neuropsychiatry of schizophrenia. Hove, UK: Lawrence Erlbaum Associates, 1994. p. 163-78.
[42] Nathaniel-James DA, Brown R, Ron MA. Memory impairment in schizophrenia: its relationship to executive function. Schizophr Res 1996;21:85-96.
[43] Tamlyn D, McKenna PJ, Mortimer AM, Lund CE, Hammond S, Baddeley AD. Memory impairment in schizophrenia: its extent, affiliations and neuropsychological character. Psychol Med 1992; 22:101-15.
[44] Goldman-Rakic PS. The physiological approach: functional architecture of working memory and disordered cognition in schizophrenia. Biol Psychiatry 1999;46:650-61.
[45] Bogerts B. The temporo-limbic system theory of positive schizophrenic symptoms. Schizophr Bull 1997;23:423-35.
[46] Fletcher P, McKenna P, Friston KJ, Frith C, Dolan RJ. Abnormal cingulate modulation of fronto-temporal connectivity in schizophrenia. Neuroimage 1999;9:337-42.
[47] Guillem F, Bicu M, Semkovska M, Debruille JB. The dimensional symptom structure of schizophrenia and its association with temperament and character. Schizophr Res 2002;56:137-47.