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ORIGINAL PAPER

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Neurocognitive and psychopathological correlates of self-monitoring ability in schizophrenia

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Abstract In a previous study reported by our group one salient finding was that many patients with schizophrenia appeared to be unable to judge their own quality of life (QoL) and that this inability was associated with negative symptoms. The association between negative symptoms, poor self-monitoring capacity and lack of insight might be explained by a common underlying factor, i. e. neurocognitive impairment. Fifty schizophrenic patients were examined by symptom ratings and a comprehensive neuropsychological test battery. The cognitive performance of the patients was very poor. The major findings of the present study were the association between clinically rated Lack of judgement (PANSS G12) and 1) a set of standard performance and executive indices of the computerised tests, and 2) difference scores between objective performance/strategies and self-ratings of the same attributes. There appears to be a substantial contribution of cognitive and executive problems to the poor judgement and lack of insight of schizophrenic patients, and these problems can to some extent be assessed objectively.

Key words schizophrenia · insight · self-monitoring · neurocognition · computerised tests

Introduction

To be aware about oneself and the current environment is a prerequisite for rational choices when trying to be adaptive and survive. In particular, to be aware of how other people perceive one (self-monitoring capacity) is necessary for successful social interactions. The loss of such functions causes considerable handicap. Another aspect of poor self-awareness is lack of insight, which is the most common symptom in schizophrenic patients and is far more common and stable over time than symptoms like hallucinations, delusions and even negative symptoms like anhedonia and affective flattening. In a previous study reported by our group (Nilsson and Levander 1998) one salient finding was that many schizophrenic patients appeared to be unable to judge their own quality of life which was associated with negative symptoms. In another study of aggressive schizophrenics, failure of self-monitoring of their aggressiveness was suggested as one main reason for their continued aggressive behaviour (Rasmussen and Levander 1993). The association between negative symptoms, poor self-monitoring capacity, and lack of insight might to some extent be explained by a common underlying factor, i. e. neurocognitive impairment. There are for example similarities between lack of insight in schizophrenia and anisognosia in neurological disorders, suggesting that poor insight may have a neurological basis (Amador et al. 1991). The G12 item (Lack of judgement and insight) of the Positive and Negative Syndrome Scale (PANSS; Kay et al. 1987) is a global and well operationalised 7-step estimate of lack of judgement and insight. Factor analyses of the PANSS suggest that the G12 item belongs to the factor denoted as cognitive (Kay and Sevy 1990; Lindström and von Knorring 1993). This is not trivial, some of the items of the Positive symptom factor, for instance P5 (Grandiosity) appear to be conceptually more related to G12 than the Cognitive factor items.

If we acknowledge that patients with schizophrenia suffer from poor judgement and insight as a consequence of the disease, we face several problems. One problem concerns assessment of Quality of Life (QoL). QoL is a person's own subjective evaluation of her or his life situation. A high QoL must be considered to be the "bottom-line" in the evaluation of treatment and habilitation efforts in a non-paternalistic health care system.

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In recent years, psychiatry has responded positively to consumer strivings at taking command of their lives and participate in setting priorities for the psychiatric services. However, there is a problem if one large group of consumers has serious difficulties assessing their needs. In line with this, some studies indicate that professional assessment of patient functioning, well-being and health do not always correlate well with the patient's self assessments (Andrews 1976; Campell et al. 1976; Thapa and Rowland 1989; Nilsson and Levander 1998).

Furthermore, lack of insight represents a barrier to effective treatment and optimal co-operation with the health care system. *Insight* in this context is a concept that refers to a patient's ability to acknowledge the presence of symptoms and needs characteristic of a mental illness.

Conceptually, the executive components of the cognitive factor, commonly assessed by tests like the Wisconsin Card Sorting Test (WCST), can be expected to be most strongly related to poor judgement. In line with this, researchers interested in the issue have mainly explored the relation between lack of symptom insight and the WCST. Young et al. (1993) obtained a significant correlation between WCST performance and impairment of insight. Using a discriminant analysis based on WCST data only, they were able to correctly classify more than 60 % of the subjects as being either aware or unaware of their illness. They concluded that the results supported the hypothesis that some cases of poor insight have an organic aetiology, potentially associated with frontal lobe dysfunction. According to data published by David et al. (1995) psychotic patients with insight performed about 10 points higher on verbal IQ tests compared to patients with poor insight. Lysaker et al. (1998) reported that schizophrenic patients who were unaware of their illness had frontal impairment (poor abstraction flexibility and heightened perseveration) but no global cognitive impairment compared to patients with insight.

This study aims to go beyond current operationalisations of the concept insight by analysing relations among various insight-related parameters and their relations with psychopathological symptoms and neurocognitive functions. Our main theory-driven hypothesis was that impairment in self-monitoring, assessed specifically as high scores on the PANSS G12 item (Lack of judgement/Insight) would display stronger correlations with neurocognitive (performance as well as executive) dysfunction and the PANSS cognitive factor than with other PANSS items and subscales. Another, more exploratory aim was to investigate if discrepancy scores between subjective ratings and objective indices of neurocognitive functions can be used as indices of executive problems, impaired self-monitoring and poor judgement/insight among schizophrenic patients.

Method

Subjects

From the original Nilsson and Levander (1998) group of 152 patients with schizophrenia according to DSMIV criteria, patients under age 60 from two (North East and South) of the four geographically defined psychiatric sectors of the city of Malmö (N = 71) were invited to participate in the study. Fifty subjects participated (70 % participation rate), 35 men and 15 women aged 42 ± 10 years. The average age at first hospitalisation was 26, the median number of previous acute episodes was 3, their education ranged from 8 to 15 years (mean 10), and the range of time being ill was 1 to 31 years (mean 14.5). Most of the patients were medicated with conventional neuroleptics, three had clozapine and one patient had Risperidone. Two had no medication, another two had a CPZ dose (calculated as described by Davis, 1976) under 100 mg, seven had doses between 100 and 200 mg and six patients had doses greater than 800 mg. The remaining 32 patients had doses between 200 and 800 mg. The mean dose was 485 mg. The local ethics committee (Lund University) approved the study.

Clinical Instruments

The positive and negative symptom scale (PANSS; Kay 1987) was used to assess psychiatric symptoms.

Computerised neurocognitive tests

The neurocognitive battery included tests selected from the computerised Automated Psychological Test system (APT; Levander 1987; Jensen et al. 1999, 2000). The test battery has been evaluated as "State of the art" of computerised testing by Kane (1999). Tasks and instructions are presented on a CRT screen in front of the subject, who responds by pressing keys on a custom-designed ergonomic keyboard. The specific tests from this battery are listed below.

- Finger tapping; five subtasks are presented: Tapping with the index finger, and Alternation between the index and middle finger, for both hands, and Alternation between the right and left index finger. Each test runs for 15 seconds but only the last 9 seconds are used for calculations of motor speed.
- Reaction time; this test was presented in four versions, 9 simple auditory, 9 simple visual, 17 two-choice visual stimuli, and 25 two-choice visual stimuli with auditory response inhibition for 50 % of the stimuli: "Go-NoGo".
- K-test of Selective Attention; here the task is to decide, as fast as possible, whether K is present in a set of 10 characters presented in random positions on the screen, with one second interstimulus intervals after a response. The test is presented in two versions, each with duration of 5 minutes, with either uniform squares, or randomly selected letters as distracters. Rational subjects use a global strategy in the first, and a sequential strategy in the second task.
- Word recognition; this is a lexicon decision task. The task is to decide whether a combination of letters presented on the screen is a word or is nonsensical. In total 80 Swedish 4-letter stimuli were presented, 20 each of high-frequency words, low-frequency words, pronounceable non-words and non-pronounceable non-words. Stimuli are presented with one-second interstimulus intervals after a response.
- Elithorn's Perceptual Maze (assesses visuospatial ability); here the task is to select a pathway through a triangular maze pattern that passes as many target dots as possible. The difficulty of each test item is selected according to a process control algorithm (no floor or ceiling effects). Two versions are presented, one that encourages a sequential strategy (with target information condition), and one for which a global intuitive strategy is best suited (no target information). Each version runs for 5 minutes. The subject trains on the test 5 minutes prior to the test starts.
- Long-term memory: this test is modeled on the Digit Symbol Sub-

stitution Test, but uses letters instead of symbols. During the learning phase (5 minutes) a translation table between 10 letters and digits is continuously present on the top of the screen. Letters are presented one by one in the center of the screen. The subject responds by entering the corresponding digit as fast as possible, and at the same time learns the translation list by heart. The actual memory test is administered 20 minutes later during 4 minutes when the task is the same, but without access to the translation table between digits and letters.
- Visual analog rating scales (100 scale steps with 3 anchor points) for self-ratings of speed, accuracy and performance were used before (how do you think that you will perform) and after (how did you actually perform).

Procedure

The patients filled in a set of questionnaires (not reported here) and were rated for psychopathology in one session by the second author who is a trained and experienced PANSS rater. The patient came back another day to complete the neurocognitive tests, about an hour and a half. If the patients requested they were allowed to rest between tests. They were paid a small fee of approximately $ 10 for participating.

Treatment of data

APT indices are extracted as one performance and one or more strategy indices per test. These test indices are expressed as T-scores (M = 50, SD = 10), based on a large material of healthy normal subjects. On a higher abstraction level, meta indices are created by taking results from several tests into consideration. Factor analyses of APT test results suggest that there are three orthogonal performance factors denoted IQ1, IQ2 and IQ3. They are scaled so that they, like conventional IQ scores, have a mean M = 100 and a standard deviation SD = 15 among healthy subjects. IQ1 reflects Finger tapping and Simple reaction time data. IQ2 reflects two-choice Reaction time, Selective attention and Verbal decoding speed. IQ3 reflects Vocabulary, Visuospatial skill and Long-term memory. The three IQ indices are calculated as weighted sums of the specific test results rather than as orthogonal factor scores. Therefore the three IQ indices are correlated. IQ3 correlates approximately 0.75 and IQ2 approximately 0.40 with a conventional WAIS IQ score whereas IQ1 is uncorrelated. A global index of APT performance was obtained by averaging IQ1, IQ2 and IQ3 with weights according to the number of constituent indices (denoted Current performance).

One tentative objective estimate of the patient's self-monitoring ability was obtained by calculating the absolute value of the difference between the patients self-rating of overall performance and the APT current performance score, acknowledging ±1 SD as an acceptable misjudgement (APT Objective vs Subjective PerFormance: OSPF). Thus, absolute difference scores smaller than 10 T-points are assigned the value 50. Absolute difference scores larger than 10 are assigned the value 60 minus the difference value. Thus, if the current performance T-score is 35, and the patient rates his/her performance as 63, the score will be 60 – ABS [35–63] which equals 32.

One of the standard APT strategy meta-indices reflects the preference for speed over accuracy in a range of tests (Speed/Accuracy). Within rather wide limits, this index reflects a cognitive style rather than an executive problem (Wirsén Meurling 1999). Another standard strategy meta-index reflects impulsive errors that are not explained by a preference for high speed (APT Impulsive Errors, ImpErr). This is more clearly an index of executive problems. The last-mentioned two indices are not correlated among normal subjects but inversely correlated among schizophrenic patients (Levander et al. 2001). Thus, preference for accuracy is paradoxically associated with many impulsive errors. This finding makes it meaningful to calculate a difference score between the ImpErr and the Speed/accuracy index, denoted the APT Impulsiveness/Accuracy score (I/A). High scores reflect many impulsive errors concurrently with slowness (accuracy preference) in most of the tests. Two other tentative indices of self-monitoring ability were obtained by calculating contrasts between a) objective speed/accuracy and subjective speed scores (OSSP) and b) objective impulsive errors and subjective accuracy scores (OSAP). Scores were calculated in the same manner as for the OSPF index, thus a difference of at most ± 1 SD (10 T-points) is accepted and given score 50 (see example above). In healthy controls, all these executive indices are unrelated to indices of performance, and they form at least four orthogonal factors in factor analyses of various materials.

Statistics

Correlations were calculated as the product-moment, or Kendall's tau for non-normally distributed data. α was set to 0.005 to minimise mass significance.

Results

Results for the six APT executive indices are shown in Table 1. The Speed/Accuracy mean value was markedly and significantly lower than norms, i.e. the patients preferred to go slow in the tests. The mean ImpErr score was 25 T-points higher than the norm, i.e. the patients made much more impulsive errors than expected. The three objective/subjective contrasts (OSPF, OSSP, OSAP) were much lower than the norms, i.e. the patients misjudged their performance and strategies much more than healthy normal subjects (self-monitoring failure). In contrast to findings for healthy subjects, the indices were strongly intercorrelated, which to some extent reflects that they represent pairs of contrast, but with at least 5

Table 1 Executive indices of 50 patients with schizophrenia (N = 50)

		Correlations					
Parameter	M ± SD	G12	ImpErr	I/A	OSPF	OSSP	OSAP
Speed/Accur (Tscores)	34.4 ± 23.2	–0.27	0.62	–0.90	0.55	0.66	0.56
ImpErr (Tscores)	75.5 ± 22.4	0.49		0.90	0.64	0.53	0.79
I/A	40.7 ± 39.7	–0.41			–0.67	–0.67	–0.77
OSPF	38.9 ± 11.6	–0.39				0.53	0.52
OSSP	39.9 ± 12.2	–0.25					0.40
OSAP	34.7 ± 15.4	–0.29					

$r > 0.39 \rightarrow p < 0.005$
ImpErr Impulsive errors; *I/A* Impulsive errors minus Accuracy preference; *OSPF* Objective vs Subjective Performance; *OSSP* Objective vs Subjective Speed Preference; *OSAP* Objective vs Subjective Accuracy Preference

degrees of freedom available. Cronbach's alpha, calculated on the five indices that represent executive problems (leaving out the Speed/Accuracy index), was 0.89, speaking strongly for the assumption that these indices reflect a common executive factor.

Descriptive data concerning clinical symptom ratings are presented in the Table 2 and cognitive performance data are given in Table 3. In both tables correlations with the five self-monitoring variables and the PANSS G12 item (Lack of judgement/insight) are provided. Overall the patients' cognitive performance was about 20 T-points below expectation except for the simple reaction time task, in which the average deficit amounted to approximately 40 T-points below the norm (cf. Levander et al. 2001).

The PANSS G12 parameter correlated strongly with many of the PANSS factors, but also moderately with some of the neurocognitive variables. Three of the five self-monitoring APT indices were significantly ($p < 0.005$) associated with G12; the median correlation value was 0.39 (15 percent shared variance). The correlations between G12 and the APT performance indices were generally lower than for the self-monitoring indices. The PANSS Cognitive factor correlated strongly with the APT indices OSPF ($r = -0.49$; $p < 0.001$) and Current performance ($r = -0.59$; $p < 0.001$). The other PANSS factors displayed lower correlations with the APT indices, self-monitoring as well as performance indices.

Partial correlations showed that it is the shared variance between I/A and OSPF that contributes most to the correlations between the APT cognitive indices and psychopathology assessed by PANSS. When controlling for each of them at a time, the other self-monitoring indices did not correlate with the cognitive and psychopathological variables.

There were no significant correlations between CPZ dose and symptoms/cognitive indices except for the PANSS Negative factor ($r = 0.41$) and the APT executive index ImpErr (Impulsive errors, $r = -0.40$). Thus, failure to inhibit irrelevant responses was associated with a low CPZ dose.

Table 2 Clinical symptom ratings of 50 patients with schizophrenia (N = 50), and correlations with seven self-monitoring indices

	Correlations						
Parameter	M ± SD	G12	ImpErr	I/A	OSPF	OSSP	OSAP
PANSS							
Sum	75.9 ± 20.9	0.51	–0.26	–0.44	–0.28	–0.27	–0.36
Negative	21.7 ± 5.74	0.40	0.11	–0.29	–0.09	0.00	–0.16
Excitatory	7.64 ± 3.47	0.45	0.17	–0.24	–0.02	–0.04	–0.23
Positive	13.1 ± 5.45	0.52	0.08	–0.17	–0.13	–0.25	–0.17
Anxiety	11.2 ± 3.97	–0.15	–0.15	0.04	0.10	0.08	–0.02
Cognitive	11.9 ± 4.25	0.46	0.45	–0.59	–0.49	–0.52	–0.39
Grandiosity (P5)	2.0 ± 1.4	0.36	0.11	–0.09	–0.07	–0.32	–0.11
Lack of judgement (G12)	2.8 ± 1.4		0.49	–0.41	–0.39	–0.25	–0.29

$r > 0.39 \rightarrow p < 0.005$
ImpErr Impulsive errors; *I/A* Impulsive errors minus Accuracy preference; *OSPF* Objective vs Subjective Performance; *OSSP* Objective vs Subjective Speed Preference; *OSAP* Objective vs Subjective Accuracy Preference

Table 3 APT performance (T-scores except the IQ indices) of 50 patients with schizophrenia and correlations with six self-monitoring indices

	Correlations						
APT Parameter	M ± SD	G12	ImpErr	I/A	OSPF	OSSP	OSAP
Finger tapping	26.3 ± 14.3	–0.14	0.39	–0.56	0.35	0.42	0.33
Reaction time (simple)	8.9 ± 35.9	–0.13	0.32	–0.44	0.32	0.38	0.47
Selective attention	19.7 ± 34.0	–0.29	0.62	–0.76	0.54	0.50	0.64
Vocabulary	48.3 ± 11.0	–0.37	0.57	–0.29	0.23	0.44	0.53
Verbal decoding speed	26.9 ± 30.9	–0.30	0.49	–0.67	0.57	0.42	0.60
Visuo-spatial ability	23.5 ± 17.4	–0.37	0.75	–0.72	0.38	0.53	0.57
Long-term memory	34.6 ± 8.86	–0.07	0.27	–0.41	0.28	0.09	0.16
APT Current Performance	28.4 ± 15.3	–0.37	0.77	–0.86	0.79	0.63	0.61
IQ1	48.9 ± 47.3	–0.17	0.39	–0.51	0.32	0.44	0.48
IQ2	51.4 ± 35.4	–0.41	0.68	–0.82	0.65	0.55	0.66
IQ3	67.1 ± 29.7	–0.44	0.74	–0.81	0.55	0.60	0.68

$r > 0.39 \rightarrow p < 0.005$
APT IQ indices have M = 100 and SD = 15 among healthy controls.
G12 PANSS item Lack of judgement and insight; *ImpErr* Impulsive errors; *I/A* Impulsive errors minus Accuracy preference; *OSPF* Objective vs Subjective Performance; *OSSP* Objective vs Subjective Speed Preference; *OSAP* Objective vs Subjective Accuracy Preference

Discussion

The cognitive performance of the patients was very poor, particularly for the index IQ1, which measures basic cognitive functions like response readiness and motor speed. Performance was almost as poor for the index IQ2, which measures intermediately complex cognitive functions like response selection and attention. Also IQ3, which is equivalent to a WAIS IQ score, was poor. This reflects contributions of speed and executive factors to the performance in the more complex APT tests (for instance the verbal decoding speed of the Word test and the Maze test that assesses visuospatial skill), which are not assessed by the corresponding WAIS tests. The APT IQ3 score appears to be much more sensitive to the cognitive deficits in schizophrenia than a WAIS IQ index.

The results in the executive indices should be noted. The patients preferred an accurate strategy rather than a speedy one, corresponding to a difference from norms of 15 T-points. Still, they had an extremely impulsive strategy, about 25 T-points above the norms. This, at first sight paradoxical finding, seems to characterize schizophrenic patients (Levander et al. 2001). High I/A scores reflect that a subject tries to avoid impulsive errors by slowing down the response times (or decrease response readiness), but fails to attain that. They are still unable to inhibit inappropriate impulsive responses.

The major finding of the present study is the association between clinically rated Lack of judgement/Insight (PANSS G12) and the APT executive/self-monitoring indices. The highest correlation was obtained for the ImpErr score, which has some face validity. It is a reasonable assumption that there is a link between lack of judgement and frontal dysfunction of the kind that leads to impulsiveness and inability to inhibit inappropriate responses. Another salient finding is the moderately strong but significant ($p < 0.005$) associations between PANSS G12, on the one hand, and the difference score between objective performance/strategies and self-ratings of the same attributes (OSPF, OSSP, OSAP).

In contrast to data for healthy normal subjects, the APT executive indices were strongly related to cognitive performance. This corresponds with previous reports that patients unaware of their illness scored ten points lower in verbal intelligence compared to patients with insight (David et al. 1998). The pattern of significant correlations between G12, PANSS factors and APT performance and executive indices suggests that impaired self-monitoring gets contributions from different sources of variance. In our data, the strongest contributions are from the PANSS Positive and Cognitive factors, and from APT performance as well as executive/self-monitoring indices. The separate contribution to the prediction of G12 from the APT executive indices is noteworthy. Furthermore, the strong relation obtained between the PANSS cognitive factor and the APT Current Performance parameter suggests that the clinical ratings underlying the PANSS cognitive factor actually reflect the same cognition processes that are assessed by neuropsychological methods employed in the APT battery. These findings do not appear to be confounded by drug dose effects. We obtained only two significant correlations between drug dose and symptoms/cognitive indices, and in addition, one of these had a reversed sign in relation to a reasonable expectation.

The significant association between G12 and the APT self-monitoring indices suggests that the idea of using a discrepancy score between objective and subjective neurocognitive performance to assess "insight" in an objective way is valid. Specifically, the score reflecting the discrepancy between subjective and objective performance (OSPF) is the most "objective" of the APT self-monitoring indices; it has face validity and probably some ecological relevance. The problem of interviewer bias is eliminated in such a measure. It also takes into account the patients who grossly underestimate their performance, which eight of the subjects did in the present study.

The hypothesis raised in the previous study by Nilsson and Levander (1998) that schizophrenic patients' difficulties in rating their QoL might depend on cognitive impairment, including poor self-monitoring capacity, rather than negative symptoms is to some extent corroborated by the findings of the present study.

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