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Psychopathological dimensions in schizophrenia: a correlational approach to items of the SANS and SAPS

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Abstract

Seventy DSM-III schizophrenic patients were assessed for positive and negative symptoms using Andreasen's scales for the assessment of positive and negative symptoms (SANS and SAPS) on admission. The correlation structure of the items in the SANS and SAPS was explored in dimension and item levels by use of correlation plots through a distinct analytical method displaying the proximity matrix. The results revealed at least three major dimensions of symptoms delineated as Negative Symptoms, Disorganized Thoughts and Delusions and Hallucinations. The latter two dimensions were derived from the SAPS, while Negative Symptoms comprised most of the items in the SANS. Items in Disorganized Thoughts were more correlated to Negative Symptoms than to the other items in the SAPS. 'Loss of ego boundary' delusions and experience of auditory hallucinations appeared as two sub-clusters in the group of Delusions and Hallucinations. The relative independence of persecutory, grandiose, religious, somatic and reference delusions gives support to the concept that paranoid schizophrenia stands as a distinct clinical subtype of schizophrenia. The graphical method introduced here well expresses the information of correlation matrix and is useful for exploring inter-item or inter-cluster associations. © 1998 Elsevier Science Ireland Ltd.

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1. Introduction

Various rating scales for measuring positive and/or negative symptoms have been proposed since the work of several groups (Strauss et al., 1974; Crow, 1980, 1985; Andreasen and Olsen, 1982; Andreasen et al., 1982) led to extensive interest in this dichotomy of schizophrenic symptomatology. A series of reports (Arndt et al., 1991; Minas et al., 1992, 1994; Malla et al., 1993; Klimidis et al., 1993; Andreasen et al., 1995; Stuart et al., 1995) using the SANS and SAPS [Scale for the Assessment of Negative Symptoms (Andreasen, 1983); Scale for the Assessment of Positive Symptoms (Andreasen, 1984)] and some using other psychometric scales (Liddle, 1987; Kay and Sevy, 1990; Sarai and Matsunaga, 1993; Lindenmayer et al., 1995b) indicated that, in contrast to the conventional positive and negative syndromes, an independent third dimension of thought disorder or disorganization syndrome may be an underlying form of symptomatology in schizophrenia.

The major analytic strategies in the literature to explore underlying dimensions of measured psychopathology usually involve multidimensional scaling (MDS) or factor analysis (FA) techniques. Both approaches address issues of the empirical cohesiveness of sets of symptoms and the independence of dimensions. However, the approach of analysis of ratings is crucial. There is a substantial risk of obliterating the relationships between individual symptoms, or even subgroups of symptoms, and external validators (e.g. illness course, treatment outcomes and biological correlates) if the composite of scale items is segregated and grouped inappropriately. Some researchers employed a global or subscale rating approach (Arndt et al., 1991; Sarai and Matsunaga, 1993; Klimidis et al., 1993) and others applied an approach to individual items (Liddle, 1987; Minas et al., 1992, 1994; Malla et al., 1993; Stuart et al., 1995). Several investigators indicated that different approaches had distinct implications (Minas et al., 1992, 1994; Stuart et al., 1995). Whether the strategy of analysis would have influence on the measured profile of psychopathological dimensions needs further attention.

The SANS and SAPS are widely known for

their high reliability and used to demarcate the dimensions of schizophrenic symptoms. However, questions have been raised as to the validity of their internal construct and subgroup composition (Minas et al., 1992, 1994; De Leon et al., 1993; Klimidis et al., 1993; Malla et al., 1993; Sarai and Matsunaga, 1993). Given this scenario, the strategy of an item-level approach for depicting the more homogenous clusters of psychopathology in schizophrenia appears important.

The aim of this study was to explore the major and sub-cluster structures that delineate the psychopathological dimensions of the SANS and SAPS items in a sample of Chinese schizophrenic patients. We used correlation plots with an item-level approach to reveal clustering of the SANS and SAPS items through a new graphical method.

2. Methods

2.1. Subjects and clinical rating

Seventy patients (41 male; 29 female) with DSM-III (American Psychiatric Association, 1980) diagnoses of schizophrenia were recruited after giving written consent. Patients ranged in age between 16 and 54 years (mean age = 28.2; S.D. = 7.0); mean duration of illness was 42.8 months (S.D. = 50.7). The subjects were all experiencing a significant array of psychotic symptoms when admitted to the acute inpatient wards of two university-affiliated hospitals.

Clinical diagnoses were assessed with a semi-structured psychiatric diagnostic assessment interview schedule as described by Hwu et al. (1986) and supplemented with clinical data from the medical charts. Patients with the DSM-III diagnoses of organic mental disorders and mental retardation were excluded from the study. The SANS and SAPS were completed by the end of the first week after admission by the attending psychiatrist. All of the subjects were receiving antipsychotic treatment when assessed. The raters were familiar with these measuring scales. The inter-rater reliabilities were between 0.82 and 0.92 for the SAPS and between 0.73 and 0.88 for the SANS as determined by the Spearman rank correlation. Items of low base rate, i.e. frequency of

occurrence (ratings scored ≥ 2 in the SANS or SAPS) less than 10%, were excluded, yielding 43 items for analysis (Table 1).

2.2. Statistical and graphical method

We used generalized association plots (GAP) [Chen (1996): summarized PC program available on request], a graphical environment for general purpose multivariate analyses, as the major analytical tool. This approach takes advantage of the computer's superior computing power and graphing ability to retrieve important pieces of information embedded in all different kinds of raw data matrices and proximity matrices.

In our study, a Pearson's product-moment correlation matrix of the 43 symptoms was used as the input proximity matrix to the GAP program. Given a proximity matrix, GAP first represents the matrix graphically as a color map (correlation plot) with variables in the matrix sorted by a random order (Fig. 1a) or by a user specified

order (Fig. 1b). Each of the proximity measures (correlation coefficients) in the matrix is represented by a colored dot. For our correlation matrix, the blue–red color spectrum with 100 levels was employed to illustrate the bi-directional nature of the correlation coefficients.

In Fig. 1a, the randomly-sorted correlation plot does not give us much more information than the usual correlation matrix of numbers, while the overall pattern in Fig. 1b presents a somewhat clearer clustering effect. Delineating an overall profile of the symptom structure, Fig. 1b can be further sorted to study the within- and between-group symptom relations in a more revealing manner.

3. Results

3.1. Tree diagram

Among many sorting algorithms from the GAP

Table 1
Forty-three SAPS and SANS items included in analysis^a

SAPS		SANS	
AH1	Auditory hallucinations	NA1	Unchanging facial expression
AH2	Voices commenting	NA2	Decreased spontaneous movements
AH3	Voices conversing	NA3	Paucity of expressive gestures
VH	Visual hallucinations	NA4	Poor eye contact
DL1	Persecutory delusions	NA5	Affective non-responsivity
DL4	Grandiose delusions	NA6	Inappropriate affect
DL5	Religious delusions	NA7	Lack of vocal inflections
DL6	Somatic delusions	NB1	Poverty of speech
DL7	Ideas and delusions of reference	NB2	Poverty of content of speech
DL8	Delusions of being controlled	NB3	Blocking
DL9	Delusions of mind reading	NB4	Increased latency of response
DL10	Thought broadcasting	NC1	Grooming and hygiene
DL11	Thought insertion	NC2	Impersistence at work or school
DL12	Thought withdrawal	NC3	Physical anergia
BEH1	Clothing and appearance	ND1	Recreational interest and activities
BEH2	Social and sexual behavior	ND2	Sexual interest and activity
BEH3	Aggressive and agitated behavior	ND3	Ability to feel intimacy and closeness
TH1	Derailment	ND4	Relation with friends and peers
TH2	Tangentiality	NE1	Social inattentiveness
TH3	Incoherence	NE2	Inattentiveness during MSE
TH4	Illogicality		
TH5	Circumstantiality		
TH7	Distractible speech		

^aSeven items excluded due to low base rates.

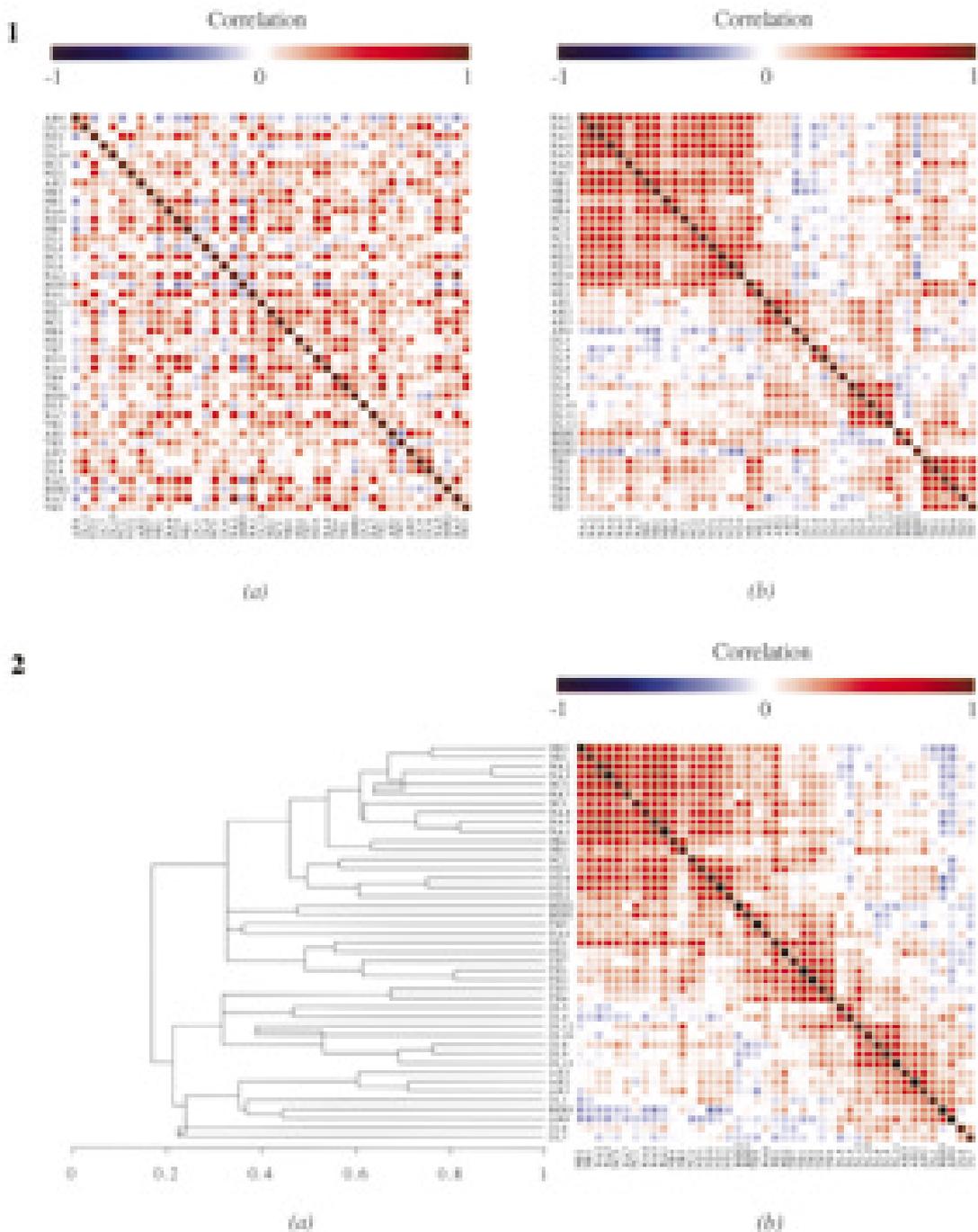


Fig. 1. Correlation plots. The numeric correlation coefficients (-1 to 1) are illustrated in a blue–red color spectrum of 100 block levels. (a) Symptoms are sorted by a random order. (b) Symptoms are sorted by the order as the Andreasen's SANS and SAPS table. Fig. 2. Divisive clustering tree with sorted correlation plot. (a) Number in the horizontal scale represents the average correlation coefficient for the submatrix under each node. (b) The sequence of symptoms in the correlation plot is sorted according to the order of the items determined by the terminal nodes in the clustering tree.

program, the tree diagram can provide us, in addition to the sorted correlation plot, further information for clustering the symptoms. The correlation matrix of 43 symptoms was decomposed into two disjoint sub-matrices of 26 and 17 items according to the converging property of the iteratively formed sequence of correlation matrices [see also McQuitty (1968) and Breiger et al. (1975) for earlier applications of the dichotomous converging pattern of the sequence of correlation matrices]. This process of decomposition continues until each terminal submatrix contains only one symptom item. The tree diagram (Fig. 2a) illustrates this recursive partitioning of the submatrix sequence.

The branches of the tree diagram are then permuted according to the relative mean levels of between-group (submatrices) correlation so that symptom groups with higher means of between-group correlation stay close to each other in the clustering tree diagram. The horizontal scale in the tree diagram indicates the average correlation coefficient for the submatrix under each corresponding node.

3.2. Correlation plots

The correlation map sorted by the order of the terminal nodes in the tree diagram is then plotted as Fig. 2b. Fig. 3 further reveals the relations among purported items or clusters by excluding the items within indicated ranges of correlations. It is apparent that the SANS and SAPS items do not merge into two discrete, coherent groups that can adequately delineate the structure of the correlation matrix. Instead at least three major symptom clusters can be delineated here as Negative Symptoms, Disorganized Thoughts and Delusions and Hallucinations. The Negative Symptoms comprise most of the items in the SANS. The items of the SANS clearly form a more coherent group than do those of the SAPS. Blocking (NB3) and increased latency of response (NB4), though closely correlated to each other, show different patterns of relation to other items in the SANS. NB4, unlike NB3, shows fair correlation to other items of Negative Symptoms. However, NB3, but not NB4, has moderate correlation with several items of Disorganized Thoughts and ‘loss of ego

boundary’ delusions (i.e. thought withdrawal, thought broadcasting, delusions of being controlled, delusions of mind reading and thought insertion).

A second cluster, Disorganized Thoughts, includes derailment, tangentiality, incoherence, illogicality and less coherent, distractible speech. Lying in between are several items simultaneously correlated (most of them loosely) with Negative Symptoms and Disorganized Thoughts, such as clothing and appearance (BEH1), social and sexual behavior (BEH2), circumstantiality (TH5), inappropriate affect (NA6) and items of attentional problems (NE1, NE2). With little correlation to most of the other items in the plot, grandiose delusions (DL4) and religious delusions (DL5) lie in between the Disorganized Thoughts and another major group.

The third major dimension, Delusions and Hallucinations, contains two moderately correlated subgroups, namely, delusions of ‘loss of ego boundary’ and items of auditory hallucinatory experiences (i.e. voices conversing, voices commenting and auditory hallucinations). Aggressive and agitated behavior (BEH3) and visual hallucinations (VH) had mildly negative correlations to Negative Symptoms. Like items of grandiose delusions and religious delusions, persecutory delusions (DL1), somatic delusions (DL6) and reference delusions (DL7) manifest relative independence of other items of the SANS and SAPS.

4. Discussion

We present a graphical tool, the correlation plot, to illustrate the major dimensions and sub-dimensions of the SANS and SAPS items. The analytical strategy we used has distinct implications in exploring the dimensions of schizophrenic psychopathology as measured by the SANS and SAPS.

Factor analysis and MDS are the most common techniques used in the literature to study the structure of correlation matrices on schizophrenic psychopathology (Minas et al., 1992; Klimidis et al., 1993; Andreasen et al., 1995; Stuart et al., 1995). These statistical strategies are dimension reduction approaches which approximate the structure of correlation matrices by low dimensio-

nal spatial coordinates. Because of approximation, both methods suffer from loss of information contained in the original proximity (correlation) matrices. FA uses one minus the total variance explained by the leading factors with large eigenvalues (usually greater than one), while MDS employs the stress score to represent this loss of information by approximation (dimension reduction). To achieve a low (usually two) dimensional result with low stress score (or high R^2 score), MDS usually needs to exclude some objects (symptoms) of low commonalities with other objects from the analysis (Minas et al., 1992). For FA, relevant information may be disregarded in the factors with small eigenvalues, although FA does not need to exclude the low commonality objects in advance.

The sorted correlation plot we used has some advantages over FA and MDS. First, the correlation plot requires only a 2-dimensional color map with blocks of dark red points on the main-diagonal to reveal all the possible equivalent factor loadings in FA and groups of symptoms in MDS. Second, the blue points in a correlation plot indicate symptoms with negative correlations, while two far-separated symptoms in an MDS plot do not necessarily have negative correlation. Third, the correlation plot retains each piece of correlation in the matrix as a colored point. The user has easy access to all the information of correlation in the plot. Fourth, the sequence of clustering of the symptoms was revealed by the tree diagram. Various seriation algorithms may find slightly different permutations of the correlation matrix. As long as the permuted seriation is not much different from the presumably best one in all 43 possible seriations, one should be able to recognize most of the correlation information contained in the original matrix by examining the sorted correlation matrix map. One of the major advantages of the GAP environment is that every single correlation coefficient from the input proximity matrix is maintained in the output sorted proximity matrix map. We think that the correla-

tion plot can be used to complement, not to replace, the existing multivariate tools in performing a more comprehensive data analysis.

Our data revealed that at least three major dimensions of symptoms were measured by the SANS and SAPS, i.e. Negative Symptoms, Disorganized Thoughts and Delusions and Hallucinations. Our results support a valid distinction between Delusions and Hallucinations and Negative Symptoms, both representing discrete, but not co-exclusive or inversely related, dimensions of schizophrenic symptoms. Meanwhile, in parallel with several previous reports (Minas et al., 1992, 1994; Malla et al., 1993; Stuart et al., 1995), our findings showed that the simple dichotomy of positive and negative syndromes does not suffice to demarcate adequate profiles of psychopathology in schizophrenia.

Another main finding is that Disorganized Thoughts may well be independent from Negative Symptoms and Delusions and Hallucinations. This has been shown through various lines of research: those employing the SANS and SAPS (Minas et al., 1992, 1994; Malla et al., 1993; Klimidis et al., 1993; Andreasen et al., 1995; Stuart et al., 1995), those with other scales (Liddle, 1987; Sarai and Matsunaga, 1993) and one with a different ethnic sample group (Kulhara et al., 1986). As reflected in our results and these reports, it seems that differences in ethnicity and cultural group of patients do not bring about a significant discrepancy in the dimensionality. Furthermore, given the notion that our patients were suffering from schizophrenia in an acute or exacerbated phase, the segregation of the disorganization syndrome appeared not to differ from that in the samples of chronic cases (Liddle, 1987; Sarai and Matsunaga, 1993).

In the present study, Disorganized Thoughts are composed of items from the SAPS. Interestingly, the items associated with Disorganized Thoughts are more positively correlated with Negative Symptoms than with Delusions and Hallucinations. Fenton and McGlashan (1994) indi-

Fig. 3. The sectional correlation plots in series. The blank bars indicate the ranges of correlations within which corresponding items were excluded.

cated that, over the course of many years, symptoms of thought disorder (and bizarre behavior) might increase among patients who also have prominent persistent negative symptoms. It is necessary to accommodate the syndromal independence of disorganized thoughts and observe its long term relation with Negative Symptoms in future studies.

The items of the SAPS appeared not a very coherent group as we examined the structure of the correlation plot. Clearly, Disorganized Thoughts can be demarcated from the other SAPS items. The SAPS includes several Schneiderian first-rank symptoms. Our results revealed that those first-rank symptoms adopted in the SAPS emerged into two moderately correlated sub-clusters as 'loss of ego boundary' delusions (i.e. delusions of being controlled, delusions of mind reading, thought broadcasting, thought insertion and thought withdrawal) and the group of auditory hallucinatory phenomena (i.e. auditory hallucinations, voices commenting and voices conversing), which is consistent with a recent report of Stuart et al. (1995). Moreover, the evidence that 'loss of ego boundary' delusions were correlated only loosely with the other delusions supports the view that they should be treated as distinct from hallucinations and other types of delusions. Unlike the other items in 'loss of ego boundary' delusions, thought withdrawal shows moderate or fair correlation with items of Disorganized Thoughts, which is consistent with the finding of Mellor (1970). These findings are compatible with the classical description by Carl Schneider (Schneider, 1942) of a thought withdrawal ('Gedankenentzug') group of acute schizophrenics with symptoms including thought withdrawal, verbal derailment, blocking and breaking off of thoughts. The psychopathological implication of the relationship between 'loss of ego boundary' delusions and formal thought disturbances is an issue that needs further investigation.

Furthermore, persecutory, religious, grandiose, reference and somatic delusions showed independence from other delusions, hallucinations and thought disturbances. Given the empirical impression that paranoid schizophrenia is distinct from its non-paranoid counterpart in several as-

pects (e.g. treatment outcome and prognosis), it is reasonable to consider these paranoid delusions as an even further symptom dimension (Minas et al., 1992; Stuart et al., 1995). Taken together, our results of relation profile among the items in the SAPS concur with the notions that the SAPS does not assess a unitary construct of 'positive' psychotic symptoms and that the strategy of taking the SAPS total score as a direct measure of 'positive' symptoms is not appropriate (Minas et al., 1992; Stuart et al., 1995). The interrelations among the items of Delusions and Hallucinations in the SAPS need further exploration.

Both the SANS and SAPS have several items in the same subscale and show disparity in the correlations with respective symptom subgroups. The bizarre behaviors subscale items of social and sexual behavior (BEH2) and clothing and appearance (BEH1) of the SAPS are more closely related to Negative Symptoms and Disorganized Thoughts than to Delusions and Hallucinations. Meanwhile, aggressive and agitated behavior (BEH3) has little relation to the Negative Symptoms. Thought blocking (NB3) and increased latency of response (NB4), both being items of the alogia subscale, differed in their correlations with most other Negative Symptoms, Disorganized Thoughts and several 'loss of ego boundary' delusions (Miller et al., 1993). This may imply that thought blocking should be considered a symptom closer to formal thought disorders than to Negative Symptoms. Furthermore, unlike most other Negative Symptoms to which they are closely correlated, the items in avolition-apathy (NC1–3), a subscale intended to examine dysfunction in self-care and persistence at work, are also moderately associated with Disorganized Thoughts (Liddle, 1987). Another parallel finding is that, though closely associated with each other, the items of attentional impairment were respectively correlated with different subgroups of symptoms. That is, inattentiveness during MSE (NE2) was more closely associated with Disorganized Thoughts; social inattentiveness (NE1), with Negative Symptoms. While usually recognized as significant dysfunctions, attentional problems have been allocated to various dimensions of schizophrenic symptomatology in different reports. They were

taken as symptoms of the disorganization syndrome (Liddle, 1987; Sarai and Matsunaga, 1993), items of the negative component (Andreasen, 1983; Kay and Sevy, 1990; Malla et al., 1993), or manifestations secondary to positive features (Carpenter et al., 1985), even as equally presented with negative and positive syndromes (Bilder et al., 1985; Kay et al., 1986). This implies that items allocated together in the same subscale by semantic presumption may not share common psychopathology and may be apparent in different contexts. Whether they represent separate processes or similar psychopathology mediated by different coexisting disturbances (e.g. disorganization or negative symptoms per se) warrants further clarification.

This study has inherent limitations. First, the sample size may be relatively small. We suspect that different sample sizes may have some minor changes on the finer structure, but not the overall pattern. Second, our sample consisted of patients in acute phases of illness. However, it would be more informative to further validate these symptom dimension entities in specific subgroups of patients for a longer course through different phases of illness (e.g. acute vs. chronic; exacerbated vs. stable). Third, this study explored the psychopathological dimensions derived from items in the SANS and SAPS. However, it has been pointed out that the SANS and SAPS do not measure mood disturbances which are not uncommonly present in patients with schizophrenia (Minas et al., 1994). Different lines of research employing scales with items of mood profile, such as the Positive and Negative Syndrome Scale (PANSS) (Kay and Sevy, 1990; Lindenmayer et al., 1995a,b), reported additional dimensions of depression and excitement in schizophrenia.

The symptom clusters discussed in this study were statistically segregated and may well be treated as dimensions rather than discrete categories of schizophrenia. Carefully interpreted, the identification of clinically correlated symptom clusters may help define more homogenous dimensions of psychopathology in schizophrenia. Taking the above notions together, we can more critically examine the actual relationships between

symptom assessment, psychopathological construct and external validation measures.

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