Factor analysis of positive and negative syndrome scale in schizophrenia: An exploratory study

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ABSTRACT

Background: Controversy persists with regard to how best we can categorize symptomatic dimension of Schizophrenia. Aim of the study was to compute factorial dimensions in Indian subset of schizophrenic patients and to compare them with five factor pentagonal model extracted in western studies.

Materials and Methods: 150 inpatients of Schizophrenia with acute exacerbation were subjected to PANSS rating within one week of admission and statistical calculation done based on exploratory factor analysis.

Results: Five factors namely negative, autistic, activation, positive and depression were extracted wherein negative factors showed highest percentage of total variance supporting five factor modal of western literature

Conclusion: A consensus is gradually emerging regarding symptomatic dimensions of Schizophrenia.

Key words: Factor analysis, positive and negative syndrome scale, schizophrenia

INTRODUCTION

Schizophrenia is a heterogeneous disorder with diverse history, symptoms, and subtypes. These subtypes may be distinguishable from each other with respect to prognosis, course, or response to treatment. Their identification is of utmost importance from a clinical perspective. Earliest diagnostic refinements involved the subdivision of schizophrenia into positive and negative syndromes. De delusions, hallucinations, and bizarre behavior were part of positive schizophrenia, while blunted affect, avolition, and attentional problems were salient features of negative schizophrenia. To investigate the positive–negative dichotomy empirically, measurement instruments such as the Scale for the Assessment of Negative Symptoms (SANS) and the Scale for the Assessment of Positive Symptoms (SAPS) were designed. However, empirical analyses of these scales showed that positive symptoms can be further subdivided into psychotic and disorganized symptoms, suggesting that the positive–negative distinction does not fully explain the complex structure of schizophrenic symptoms.

The SANS and SAPS were developed to measure positive and negative syndromes. Because of a hypothesized selection of symptoms, these instruments may be limited in their potential to identify schizophrenia subtypes. To allow a more extensive assessment of schizophrenia symptoms, Kay et al. used the Brief Psychiatric Rating Scale developed by Overall and Gorham and the Psychopathology Rating Schedule developed by Singh and Kay to create more comprehensive Positive and Negative Syndrome Scale (PANSS). Many of the 30 items of the PANSS are not directly related to the positive and negative syndromes. To unravel the structure of the PANSS items, a considerable number of factor analyses have been performed. In these studies, the number of underlying factors derived varied, as were the PANSS items included in scales presumably measuring the same subtype.

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In an endeavor to reconcile different research findings, White and colleagues[9] fitted 20 previously proposed models to data from a sample of 1233 schizophrenics. They concluded that none of these models fitted the data adequately. The authors then derived a new model by performing exploratory factor analysis (EFA) in one-half of the data and cross-validating the derived model in the other half of the data. The five factors from this pentagonal model were labeled: positive, negative, dysphoric mood, activation, and autistic preoccupation. It is this five-factor model that is presently proposed in the manual for the PANSS.[10] However, controversy surrounding the factor structure of the PANSS did not end with the study of White and colleagues.[11-13] Critics argued that five factors may not be good enough to capture the structure of the PANSS items,[14] and the proposed pentagonal model gives an inadequate goodness of fit in other sample.[14]

Major work in the field of factor subtyping of schizophrenia in India has been done by Kulhara et al. and Kulhara and Chandramani, with focus on positive–negative dichotomy in the background. Keeping in view that in India there is dearth of studies on factor analysis of schizophrenia using PANSS and taking into account that there is an ongoing endeavor to recognize a uniform and homogenous symptom structure of schizophrenia transcending cross-cultural variations, ours was an attempt in the same direction to assess PANSS factorial model in Indian set-up so as to analyze psychopathological dimensions in factorial format with those obtained in western literature.

MATERIALS AND METHODS

Index study was carried out to identify factors of schizophrenia by factor analysis using PANSS. This study was prospective, naturalistic, hospital based, conducted in Central Institute of Psychiatry (CIP), Ranchi, in which subjects were enrolled using purposive sampling method. To maintain homogeneity and to reduce the gender bias, if any, in the findings, 100 male and 50 female inpatients were enrolled in this study from March 2008 to August 2009. Cases diagnosed of schizophrenia as per the ICD-10 criteria, from either gender, in between 18 and 55 years of age, were enrolled after obtaining their written informed consent. Schizophrenic subjects with other comorbid conditions (medical, substance use, mental retardation, etc.) were excluded. Due clearance from ethical committee of the institute was taken and all assessments were performed by the same researcher. Socio-demographic clinical data sheet was used for screening and appropriate selection of the subjects. Selected subjects within a week of admission were evaluated on PANSS. PANSS developed by Kay et al.[6] was used to assess individuals with schizophrenia for factor analysis and comprises a semi-structured clinical interview containing 30 items rated along a 7-point continuum (1=absent, 7=extreme). The assessment provides separate scores in several clinical domains including a positive syndrome (7 items), a negative syndrome (7 items), and general psychopathology (16 items), among others. The data collected were statistically analyzed using Statistical Package for Social Sciences (SPSS) 13.0 for Windows 98. For summarizing the data (both socio-demographic and clinical), mean and standard deviation were calculated. Discrete data were expressed in percentage. A factor analysis was done on complete data. Samples were subtyped as per the found factor structure of PANSS.

RESULTS

Tables 1 and 2 show the details of socio-demographic and clinical characteristics of the subjects, respectively.

| Table 1: Socio-demographic variables |
|-------------------------------|--------|------|
| Sex                           | n      | %    |
| Male                          | 100    | 66.6 |
| Female                        | 50     | 33.4 |
| Religion                      |        |      |
| Hindu                         | 124    | 80.5 |
| Muslim                        | 19     | 12.3 |
| Christian                     | 7      | 4.5  |
| Occupation                    |        |      |
| Unemployed                    | 126    | 81.8 |
| Employed                      | 24     | 15.6 |
| Marital status                |        |      |
| Single                        | 48     | 31.2 |
| Married                       | 95     | 61.7 |
| Others                        | 7      | 4.5  |

| Table 2: Clinical variables |
|----------------------------|--------|------|
| Age                          | Mean   | SD   | N    | %    |
| Onset age                    | 27.41 Yrs | 7.62 Yrs | 98 | 61.7 |
| Duration of illness          | 5.52 Yrs | 4.69 Yrs | 100 | 66.6 |
| Education                    | 8.94 Yrs | 5.11 Yrs | 100 | 66.6 |
| Consultation                 |        |      |
| Nil                          | 44     | 28.6 |
| 1 - 2                        | 45     | 29.2 |
| 3 or more                    | 61     | 39.6 |
| Hospitalization              |        |      |
| Nil                          | 97     | 63   |
| 1-2                          | 41     | 26.6 |
| 3 or more                    | 12     | 7.8  |
| Schizophrenia type           |        |      |
| Paranoid                     | 113    | 73.4 |
| Undifferentiated             | 27     | 17.5 |
| Others                       | 10     | 6.4  |
| Mode of onset                |        |      |
| Abrupt                       | 4      | 2.6  |
| Acute                        | 9      | 5.8  |
| Insidious                    | 137    | 89   |
| Course                       |        |      |
| Continuous                   | 124    | 80.5 |
| Remitted                     | 24     | 15.6 |
| Others                       | 2      | 1.3  |
| Progress                     |        |      |
| Static                       | 1      | 0.6  |
| Improving                    | 2      | 1.3  |
| Deteriorating                | 147    | 95.5 |

Yrs - Years, N - Numbers
The mean age of the group was 32.97±8.02 years. Mean age of onset of schizophrenia was 27.41±7.62 years, whereas mean duration of illness was 5.52±4.69 years. As shown in Table 2, majority of the subjects had less than two consultations (57.8%), 64% had no prior hospitalization prior to the present admission, paranoid schizophrenia was diagnosed in 73.4% with undifferentiated schizophrenia being the second most common diagnosis in the sample. In this subject population, 89% had insidious onset, 80% had continuous course, and majority 95% had deteriorating progress.

EFA was conducted with 30-item PANSS followed by principal components extraction with Varimax rotation. Bartlett’s test of sphericity yielded a significant chi-square statistics, indicating that relationship exists between at least some of the subscales (chi square 17,260.043; df 435; sig. 0.001). Analysis also produced a Kaiser Meyer Olkin (KMO) value of 0.816 (measure of sample adequacy), indicating satisfactory sample adequacy. As per field[17] a sample is adequate if the KMO value is more than 0.60. To avoid overestimation and to retain meaningful and most appropriate factors, a number of criteria as given below were used [Figure 1]:

a. Minimum eigenvalue of 1
b. Minimum factor loading of 0.45 and above
c. Minimum factorial complexity (multiple loading)
d. Meaningful interpretation of the factor
e. Percentage of extracted variance (5%)

A scree test between factors was plotted to consolidate the total number of factors to be extracted in factor analysis. The scree plot based on the cut-off eigenvalues further guided toward the number of factors to be retained for further analysis.

Based on EFA, as shown in Table 3, eight factors captured 62.56 % of the unrotated and rotated variances. Factor six, seven, and eight only had one item in them, accounting for 11.5% of variance and thus did not make it clinically meaningful enough to be incorporated for further analysis and were dropped from subsequent analysis. The first five factors, as shown in Table 4, accounted for 51.08% of variance in scores, with the factors reflecting the following: first factor (eigenvalue = 7.79 and 25.96% variance), second (eigenvalue = 2.45 and 8.17 % variance), third (eigenvalue = 1.94 and 6.48% variance), fourth (eigenvalue=1.62 and 5.39% variance), and the last fifth factor (eigenvalue = 1.53 and 5.09 variance).

Table 4 shows various PANSS items with absolute loading value greater than 0.45 incorporated in five factors.

The five factors extracted were as follows:

Factor I – Negative group: Comprising the items, namely, lack of spontaneity (loading value 0.774), blunted affect, poor rapport, passive/apathetic social withdrawal, uncooperativeness, active social avoidance, emotional withdrawal, difficulty in abstract thinking, disorientation, and motor retardation.

Factor II – Autistic/disorganized group: Comprising the items, namely, disturbance of volition (loading value 0.730), mannerisms and posturing, and poor attention.

Factor III – Activation/excitement group: Comprising the items, namely, hostility (loading value of 0.784), anxiety, tension, excitement, and poor impulse control.

Factor IV – Positive group: Comprising the items, namely, unusual thought content (loading value of 0.747), grandiosity, and somatic concern.

Factor V – Depression group: Comprising the items, namely, guilt feelings (loading value of 0.779), depression, and motor retardation.

DISCUSSION

Methodological issues

Sample size

Factor analysis is very sensitive to the size of correlation, and correlation coefficients tend to be less reliable when
### Table 3: Total variance explained (extraction method): Principal component analysis

| Component | Initial Eigenvalues | Extraction sums of squared loadings | Rotation sums of squared loadings |
|-----------|---------------------|-------------------------------------|----------------------------------|
|           | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % | Total | % of variance | Cumulative % |
| 1         | 7.79  | 25.96        | 25.96        | 7.79  | 25.96        | 25.96        | 5.09  | 16.95        | 16.95        |
| 2         | 2.45  | 8.17         | 34.13        | 2.45  | 8.17         | 34.13        | 2.57  | 8.56         | 25.51        |
| 3         | 1.94  | 6.48         | 40.60        | 1.94  | 6.48         | 40.60        | 2.51  | 8.36         | 33.87        |
| 4         | 1.62  | 5.39         | 45.99        | 1.62  | 5.39         | 45.99        | 2.03  | 6.78         | 40.65        |
| 5         | 1.53  | 5.09         | 51.08        | 1.53  | 5.09         | 51.08        | 1.95  | 6.49         | 47.14        |
| 6         | 1.30  | 4.33         | 55.42        | 1.30  | 4.33         | 55.42        | 1.67  | 5.56         | 52.69        |
| 7         | 1.13  | 3.75         | 59.17        | 1.13  | 3.75         | 59.17        | 1.65  | 5.50         | 58.19        |
| 8         | 1.02  | 3.39         | 62.56        | 1.02  | 3.39         | 62.56        | 1.31  | 4.37         | 62.56        |
| 9         | 0.96  | 3.20         | 65.76        | 0.94  | 3.13         | 68.89        | 0.85  | 2.82         | 71.71        |
| 10        | 0.94  | 3.13         | 68.89        | 0.85  | 2.82         | 71.71        | 0.83  | 2.78         | 74.48        |
| 11        | 0.83  | 2.78         | 74.48        | 0.74  | 2.45         | 76.94        | 0.71  | 2.36         | 79.29        |
| 12        | 0.71  | 2.36         | 79.29        | 0.64  | 2.03         | 81.32        | 0.58  | 1.93         | 83.25        |
| 13        | 0.57  | 1.85         | 85.10        | 0.55  | 1.85         | 85.10        | 0.51  | 1.69         | 86.79        |
| 14        |       |              |              | 0.49  | 1.62         | 88.41        |       |              |              |
| 15        | 0.47  | 1.55         | 89.96        | 0.47  | 1.55         | 89.96        | 0.43  | 1.42         | 91.39        |
| 16        | 0.43  | 1.42         | 91.39        | 0.43  | 1.42         | 91.39        | 0.40  | 1.32         | 92.70        |
| 17        | 0.40  | 1.32         | 92.70        | 0.40  | 1.32         | 92.70        | 0.39  | 1.28         | 93.98        |
| 18        | 0.39  | 1.28         | 93.98        | 0.39  | 1.28         | 93.98        | 0.36  | 1.19         | 95.18        |
| 19        | 0.36  | 1.19         | 95.18        | 0.36  | 1.19         | 95.18        | 0.34  | 1.13         | 96.31        |
| 20        | 0.34  | 1.13         | 96.31        | 0.34  | 1.13         | 96.31        | 0.29  | 0.96         | 97.28        |
| 21        | 0.29  | 0.96         | 97.28        | 0.29  | 0.96         | 97.28        | 0.26  | 0.88         | 98.15        |
| 22        | 0.26  | 0.88         | 98.15        | 0.26  | 0.88         | 98.15        | 0.21  | 0.71         | 98.86        |
| 23        | 0.21  | 0.71         | 98.86        | 0.21  | 0.71         | 98.86        | 0.18  | 0.60         | 99.46        |
| 24        | 0.18  | 0.60         | 99.46        | 0.18  | 0.60         | 99.46        | 0.16  | 0.54         | 100.00       |

### Table 4: Factor loading from the Varimax rotated factor structure matrix for the PANSS: Principal component extraction with Varimax rotation and Kaiser normalization

| Items                              | Negative | Autistic | Activation | Positive | Depression |
|------------------------------------|----------|----------|------------|----------|------------|
| Lack of spontaneity                | 0.774    |          |            |          |            |
| Blunted affect                     | 0.759    |          |            |          |            |
| Poor rapport                       | 0.735    |          |            |          |            |
| Passive/apathetic social withdrawal| 0.645    |          |            |          |            |
| Uncooperativeness                  | 0.622    |          |            |          |            |
| Active social avoidance            | 0.612    |          |            |          |            |
| Emotional withdrawal               | 0.608    |          |            |          |            |
| Difficulty in abstract thinking    | 0.485    |          |            |          |            |
| Disorientation                     | 0.484    |          |            |          |            |
| Motor retardation                  | 0.485    |          |            |          | 0.524      |
| Disturbance of volition            |          | 0.730    |            |          |            |
| Mannerisms and posturing           |          | 0.708    |            |          |            |
| Poor attention                     |          | 0.581    |            |          |            |
| Hostility                          |          | 0.784    |            |          |            |
| Anxiety                            |          | 0.630    |            |          |            |
| Tension                            |          | 0.600    |            |          |            |
| Excitement                         |          | 0.587    |            |          |            |
| Poor impulse control               |          | 0.568    |            |          |            |
| Grandiosity                        |          |          | 0.747      |          |            |
| Unusual thought content            |          |          | 0.556      |          |            |
| Somatic concern                    |          |          | 0.450      | 0.779    |            |
| Guilt feeling                      |          |          |            |          | 0.594      |
| Depression                         |          |          |            |          | 0.594      |
| % of total variance                | 25.96    | 8.17     | 6.48       | 5.39     | 5.09       |
estimated from small sample sizes. It should be noted, however, that the validity of factor analyses depends more on the loading and the number of the factors obtained rather than the number of patients included. If the correlations are strong and a few distinct factors are identified, small samples could be adequate. The factor loadings that we obtained in our study are in accordance with loading suggested by DeGeus and Denys and the factor solution that we obtained was limited to five factors.

**Socio-demographic and clinical characteristics**

Mean age of the sample in our study was 32.9±8.02 years, comparable to that of a cross-sectional study conducted among Indian patients by Kota and Kulhara and almost similar to a foreign study done by Karrow et al. (for assessing PANSS syndromes) where mean age of the sample was 31.9±10.4 years. Male participants in our study formed 66.6%, which is comparable to Karrow’s subject group (67.6%). Majority of our sample comprised paranoid schizophrenia (73.4%) and undifferentiated schizophrenia (17.5%), whereas other types of schizophrenia account for 6.4%, which is similar to Karrow et al.’s study.

**Comparison PANSS factor studies in literature versus our findings**

**Number of factors**

Since its introduction, the PANSS has been subjected to numerous factor analytic studies, in which 18–30 of PANSS items have been incorporated, leading to a variety of four- to seven-factor models. In 1997, the “PANSS study group,” after comprehensive statistical calculation including confirmatory factor analysis (CFA) followed by EFA on their subject sample, published a five-factor model referred to as the “pentagonal model.” There, however, remains controversy over the number of factors and specifically over the symptom/item loadings on the factors. Some investigators propagate four factors, with different symptom-loading patterns. Although some of these differences may be due to the item content of the scales used to measure symptoms, much of the variability may reflect measurement error due to small sample sizes relative to the number of symptom variables examined. Majority of current studies in literature have a subject population of 150 and above. All had a PANSS model containing five factors which we too were able to extract in our study.

**Number of items per factor**

While our study generated a five-factor model comprising negative, autistic, activation, positive, and depressed factors in which 23 out of 30 PANSS items were loaded, in other studies, ranging from 22 to 30 were loaded.

**Items similarities/differences in various factors**

51–55% of the total variance was explained in factor analytical study of Refs, whereas in our study, we were able to explain about 52% of the total variance. Overall, in these seven studies mentioned in the preceding paragraph, along with that of ours, it was the negative factor which showed highest percentage of total variance among the five factors. Negative factor of our study captured 29.5% variance out of 52% of total variance. The negative component remained the most stable domain of independent and homogenous psychopathology in these factor analytic studies and its constituent items were identical to a landmark replication study done by Lindenmayer et al. While many items have strong loadings and were consistently related to a particular factor across these studies, others were less specific, loading with more than one factor in the same analysis or loading with different factors in different studies. The items, namely, uncooperativeness (G8) in the negative factor, anxiety (G2) in the activation factor, and motor retardation (G7) in the depressive factor were inconsistently associated with specific factors in our study.

The items included in our second factor autistic/disorganized were entirely similar to those in the study done by Lindenmayer et al. This factor delineates an independent catatonic dimension, evidenced by inclusion of constituent symptoms, namely, disturbance of volition, mannerisms and posturing, and poor attention. Since the same set of symptoms were found to cluster in other studies, there is support for the speculation that some common pathogenetic process may underlie this set of symptoms. Most of these symptoms reflect formal schizophrenic thought disorder which has been traditionally recognized as one of the core features of this illness. In addition, disturbances in willfully initiated motoric activity (as expressed in mannerisms and posturing) are also represented in this domain. Arndt et al. describe a similar factor which contains bizarre behavior and positive thought disorder under this rubric.

For the third factor called activation factor, also popularly known as excitement factor, we found 6.5% variance (third highest item loading for this factor), consisting of five items: hostility, anxiety, tension, excitement, and poor impulse control. This factor can be considered to reflect a behavioral dyscontrol dimension, as is evident by loading of hostility, tension, and poor impulse control in various studies. Such inclusiveness of more items loading on activated group is an indicator of the presence of severe agitation found in acute schizophrenic patients as mentioned by Lindenmayer et al.

In the present analysis, the fourth factor, i.e., the positive factor, comprising grandiosity, unusual thought content, and somatic concern, clearly reflected the pathology of thought content and perceptions rather than overt behavioral manifestations such as excitement or hostility. This specific three-item only combination has not been observed in earlier studies, but their inclusion in the positive factor remained a consistent finding.

Finally, we found our fifth factor, an independent depression
factor which does not overlap with negative symptoms, pointing to the validity of the independence of negative symptom assessments. Interestingly, the depression factor in the present study did not contain “preoccupation” or “somatic concern.” The lack of somatic concern may relate to sample characteristics of the present study. Patients had been screened out if any medical problems existed in order to satisfy the inclusion criteria of the study protocol. However, there was an overlap of motor retardation item in negative and depression factors, which could have been explained on the basis of admission of exacerbated subset of schizophrenic group of patients having a strong depressive component. Moreover, since a pure depression factor devoid of the items anxiety and tension is present in our study and was not the case in other factor analytical studies,[9,13,26-28] it seems ideal that motor retardation fits better with depression factor than with negative factor.

Limitations
Inherent limitations in the present study include a limited sample size. Factor analytic solutions are partly a function of the variables entered into the analysis. When different variables are entered, different factors may appear. The factorial structure obtained in our study largely depended on the major items of PANSS, but excluded many schizophrenia symptoms. The exclusion of these symptoms would not be without consequence, since some of them might be determinants in schizophrenia structure characterization. Finally, as majority of the sample included only paranoid and undifferentiated subtype of schizophrenia and does not represent the whole population of schizophrenia, inclusion of other subtypes could have been better for generalization of the results.

CONCLUSIONS
Exploratory factor analysis using PANSS in a purposive sample of acute/exacerbated ill schizophrenic patients admitted for a short duration of 10 weeks revealed five factors: negative, disorganized, activation, positive, and depression, in agreement with the findings of existing literature of five-factor model of psychopathology in schizophrenia, highlighting the fact that there can be differences in the item loading in various factors which support the heterogeneity of findings arising in various studies because of different types of methodology employed, different statistical techniques used, and power of sample size along with differences in cross-culture and sample profile of subject populations. Strength of this study rests on moderate sample size with robust statistical analytic method utilized for the purpose of factor extraction.

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