The latent structure of psychiatric symptoms across mental disorders as measured with the PANSS and BPRS-18

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ARTICLE INFO

ABSTRACT

Raw data were used from five studies of adults with mental illnesses ($N=4{,}480$) in an attempt to identify a psychiatric symptoms factor structure, as measured by the Positive and Negative Syndrome Scale or the Brief Psychiatric Rating Scale, that was generalizable across participant characteristics. First, the fit of four extant models was tested via confirmatory factor analysis (CFA), then exploratory factor analyses (EFA) were conducted with a 50% random sample, followed by a CFA with the remaining 50% to confirm the EFA factor structure. Measurement invariance of the factor structure was also examined across diagnosis, sex, race, age, and hospitalization status. The extant models were not generalizable to these data. However, a 4-factor (*Affective, Positive, Negative, Disorganized Cognitive Processing*) model was identified that retained all items and showed invariance across participant characteristics. It is possible to obtain a psychiatric symptoms factor structure that is generalizable across patient characteristics, which has clinical and research implications. Specifically, future research examining the impact of various interventions on psychiatric symptoms among adults with mental illnesses should confirm, and assuming good model-data fit, use the 4-factor model identified in this study.

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1. Introduction

Efforts are underway to move from categorical classifications of mental disorders to a focus on dimensions of functioning (Barch et al., 2013) that cross-cut disorders (Insel et al., 2010), such as the National Institute of Mental Health's Research Domain Criteria (RDoC). Though progress has been made in understanding biological pathways underlying dimensions of functioning (Brandon et al., 2009; Huang et al., 2010; Purcell et al., 2009), similar advances have been slower to develop for self-reported and behavioral measures. The use of psychiatric symptom assessments in both clinical practice and research studies illustrate this slower than desired progress in identifying generalizable dimensions of functioning. Specifically, psychiatric symptoms among adults with serious mental illnesses, including schizophrenia, bipolar, and major depressive disorders, are a primary target of clinically- and research-based psychopharmacological and psychosocial

interventions (Mueser et al., 2002a). However, in order to evaluate the effectiveness, and generalizability, of these interventions across studies and patients, symptoms need to mean the same thing and be measured on a common metric; that is, there must be measurement invariance. Yet, an invariant model of psychiatric symptom severity, as measured via standardized research and clinical assessments, including, for example the Brief Psychiatric Rating Scale (BPRS, Overall, 1974) and the Positive and Negative Syndrome Scale (PANSS, Kay et al., 1987), which includes the 18 items from the BPRS-18, has rarely been identified for adults with mental illness (Wallwork et al., 2012). Within mixed-diagnosis samples, invariance assessments are rarely employed to test the factor structure against relevant variables, such as diagnosis and treatment setting (cf., Guy, 1976). Because of this, some studies have relied on psychiatric symptom total scores (Kane et al., 1988; McEvoy et al., 2006; Miller et al., 2005). However, latent symptom factors, not total scores, are better indicators of patient functioning and provide a more nuanced understanding of treatment effectiveness across domains of functioning (Thomas et al., 2004). Consequently, researchers also have sought to identify latent

symptom factors that describe psychiatric symptoms, but this evidence is largely disorder-specific (Biancosino et al., 2010; Pacchiarotti et al., 2013; Park et al., 2015; Wallwork et al., 2012) or based on single-study designs that are often underpowered (Grimm et al., 2015).

Even within disorder-specific evaluations of symptom severity, there is only modest consensus regarding the factor structure and composition of symptoms. For example, unitary (Reininghaus et al., 2013) and multi-dimensional models with 2–11 factors (Peralta and Cuesta, 1999) have been identified when using the BPRS-18, PANSS, or other assessment instruments. There is general agreement, however, that positive and negative factors are not adequate representations of core illness states (van Os et al., 1999); most attempts to identify the factor structure of these assessment instruments result in 4- or 5-factor solutions, commonly including psychotic/positive, negative, mood, cognitive/disorganized, and activation symptoms (Wallwork et al., 2012).

Establishing an invariant psychiatric symptoms factor structure for adults with mental illness has important clinical and research implications. For example, an invariant factor structure could be used to evaluate patients' symptom change over time, regardless of any one individual's diagnosis (Sanislow et al., 2010) or course of treatment. Additionally, psychiatric symptom factor structures may document specific areas of change or stability over time despite consistency in total scores (Thomas et al., 2004). Finally, as noted above, invariant latent factors are necessary for results to be comparable across patients and studies (Lyne et al., 2012).

2. Methods

2.1. Pooled sample

We used raw data from five studies ($N=4,480$) that had broad inclusion and minimal exclusion criteria and enrolled a range of participants, from exacerbated inpatients to partially remitted outpatients. Due to differing sampling locations and timeframes, it is unlikely that any participants were ever enrolled in more than one study.

The Facilitated Psychiatric Advance Directive Study (F-PAD; Swanson et al., 2006) investigated the implementation of a facilitated psychiatric advance directive intervention ($n=469$). Inclusion criteria were: (a) 18–65 years of age; (b) schizophrenia-spectrum or major mood disorder; and (c) currently in treatment. Data were collected between 2003 and 2007.

The MacArthur Mental Disorder and Violence Risk Study (MacRisk; Steadman et al., 1998) examined violence risk among civil psychiatric patients ($n=1,136$). Inclusion criteria were: (a) English-speaking Caucasian, African American, or Hispanic patients; (b) 18–40 years of age; and (c) schizophrenia-spectrum, depression, mania, brief reactive psychosis, delusional disorder, 'other' psychotic disorder, substance abuse/dependence, or personality disorder. Data were collected between 1992 and 1995.

The Schizophrenia Care and Assessment Program (SCAP; Swanson et al., 2004) examined clinical, functional, and service utilization outcomes for adults with schizophrenia ($n=404$). Inclusion criteria were: (a) 18–65 years of age; (b) schizophrenia; and (c) current service use. Data were collected between 1997 and 2002.

The MacArthur Mandated Community Treatment Study (MacMandate; Monahan et al., 2005) collected data regarding experience of leverage to improve treatment adherence ($n=1,011$). Inclusion criteria were: (a) 18–65 years of age; (b) English- or Spanish-speaking; (c) current outpatient treatment; and (d) first service occurred at least 6 months prior. Data were collected between 2002 and 2003.

The Clinical Antipsychotic Trials of Intervention Effectiveness Study (CATIE; Lieberman et al., 2005) examined the effectiveness of second compared to first generation antipsychotic medication among adults with schizophrenia ($n=1,460$). Inclusion criteria were: (a) 18–65 years of age; (b) schizophrenia; and (c) ability to take oral antipsychotics. Data were collected between 2001 and 2004.

2.2. Measures

The BPRS-18 (Overall, 1974) and the PANSS (Kay et al., 1987) were used to assess psychiatric symptoms in the prior week via an anchored 7-point scale (1=*Not reported*/*Not observed* or *Absent* to 7=*Very severe* or *Extreme*) indicating the presence and severity of symptoms observed during the interview or reported by the patient. The 18-item BPRS was used in the F-PAD, MacMandate, and MacRisk and the 30-item PANSS was used in the CATIE and SCAP; data were provided by study PIs.

The PANSS (Kay et al., 1987) is based on the 18-item BPRS and 12 additional items from the Psychopathology Rating Schedule (Singh and Kay, 1975). The 18 items shared between the PANSS and BPRS-18 are: *somatic concerns*, *anxiety*, *emotional withdrawal*, *conceptual disorganization*, *guilt feelings*, *tension*, *mannerisms and posturing*, *grandiosity*, *depressive mood*, *hostility*, *suspiciousness*, *hallucinatory behavior*, *motor retardation*, *uncooperativeness*, *unusual thought content*, *blunted affect*, *excitement*, and *disorientation*. The 12 additional PANSS items are: *delusions*, *poor rapport*, *passive social withdrawal*, *difficulty in abstract thinking*, *lack of spontaneity*, *stereotyped thinking*, *poor attention*, *lack of judgment and insight*, *disturbance of volition*, *poor impulse control*, *preoccupation*, and *active social avoidance*. All 30 items were included in our analyses.

2.3. Procedures

2.3.1. Ethics

Assessments were completed by trained research staff following a clinical interview. Study protocols were approved by relevant institutional review boards (IRBs). All participants gave written informed consent for the original studies and the Research Triangle Institute International IRB approved the current analyses.

2.3.2. Combining and imputing data

Item responses on the PANSS and the BPRS-18 were initially examined and certain response categories were combined due to low response frequency. For certain items, the high response categories were not well populated ($<1\%$ of responses for the pooled sample) and the higher response categories were combined such that at least 1% of the pooled sample responded in the highest observed category. For example, if less than 1% of the sample responded in category 7, then category 6 and 7 were combined. If this combination did not yield more than 1% of the sample, then response categories 5, 6, and 7 were combined. Approximately three-fourths (76%) of data were complete for the 30 items. Items had responses from approximately 41% or 100% of the total sample due to study; thus, data were essentially incomplete by design (McArdle, 1994). Twenty imputed datasets were generated and the imputation model contained all BPRS-18 and PANSS items and no auxiliary variables. Multiple imputation was carried out using Bayesian analysis (Rubin, 2004; Schafer, 1997) with an unrestricted model. In this approach, a Markov chain is constructed that is long enough for the distribution to stabilize to a common distribution. Once the distribution is stabilized, a draw is taken, which yields a dataset with complete values. Imputations were carried out using M*plus,* and the ordinal nature of the BPRS-18 and PANSS items was accounted for using an ordered logistic model, in which an underlying normal continuous latent variable