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Searching for a consensus five-factor model of the Positive and Negative Syndrome Scale for schizophrenia

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Abstract

Although the developers of the Positive and Negative Syndrome Scale (PANSS) grouped items into three subscales, factor analyses indicate that a five-factor model better characterizes PANSS data. However, lack of consensus on which model to use limits the comparability of PANSS variables across studies. We counted "votes" from published factor analyses to derive consensus models. One of these combined superior fit in our Caucasian sample (n=458, CFI = .970), and in distinct Japanese sample (n=164, CFI = .964), relative to the original three-subscale model, with a sorting of items into factors that was highly consistent across the studies reviewed.

Keywords

Schizophrenia; symptoms; cognition; PANSS

1. Introduction

The Positive and Negative Syndrome Scale (PANSS) is a 30-item rating scale designed by Kay et al. (1987) to assess dimensions of schizophrenia symptoms. Its items were originally grouped into scales for Positive Symptoms (7 items), Negative Symptoms (7 items), and General Psychopathology (16 items). Several factor-analytic studies have suggested that a five-factor model better captures PANSS structure in schizophrenia samples. In these studies, smaller groupings of items represent Positive and Negative symptoms, and three other factors consistently emerge, which we will refer to as Disorganized/Concrete, Excited,

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Contributors
R.S.W., R.F. and D.D. conducted statistical analyses on previously-collected data, RH and DRW designed and supervised the original collection of the data, and all authors (R.S.W., R.F., R.H., D.R.W. and D.D.) were involved in the writing of the manuscript.

Conflicts of interest
All authors declare that they have no conflicts of interest.

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and Depressed. The PANSS factor-analytic literature also includes four, six (Van den Oord et al., 2006), and seven-factor (Emsley et al., 2003) models, but few. Versions of the five-factor model have been used in diverse schizophrenia research areas including treatment-response (von Knorring & Lindstrom, 1995), functioning (Llorca et al., 2011), and insight (Monteiro et al., 2008). It also provides good fit in other psychotic disorders (Serretti & Olgiati, 2004) and has revealed associations in instances when the original three subscales have not (e.g. theory of mind associations, Abdel-Hamid et al., 2009). Despite the general similarity of five–factor models, no single model has achieved broad consensus, and the three original subscales are still widely used. In addition, van der Gaag et al. (2006a) failed to find adequate fit in any of 25 published five-factor model variations applied to a distinct dataset. We use PANSS five-factor models reported in the literature to guide the construction of a new "consensus" model, extending previous work by Lehoux et al. (2009). We use a larger collection of published models and test and refine the consensus model with confirmatory factor analysis (CFA). We sought additional support for the model by assessing its fit in a second, demographically distinct schizophrenia sample.

2. Methods

2.1 Measure

The PANSS is a thirty-item measure of symptom severity (Kay et al., 1987). Trained interviewers administered the PANSS as part of a structured clinical interview and scored items on a scale from 1 (asymptomatic) to 7 (extremely symptomatic).

2.2 Literature Review

We searched for articles reporting novel five-factor models of the PANSS (see supplementary materials for methods). Across included studies, the five broad factors were congruent. To determine the literature "consensus" for assignment of individual items to the five factors, we simply counted how many times, across studies, each PANSS item was assigned to each factor.

2.3 Participants

We analyzed PANSS ratings for 458 unrelated individuals with DSM-IV diagnoses of schizophrenia or schizoaffective disorder. Data were collected during their participation in the Clinical Brain Disorders Branch/National Institute of Mental Health Genetic Study of Schizophrenia, described previously (Egan et al., 2001) (Table 1). Individuals with more than two PANSS items missing, IQ below 70, history of drug/alcohol abuse, head trauma, neurological disease, or age below 18 or above 55 were excluded. All participants gave written informed consent and completed a structured diagnostic interview and neuropsychological testing as part of a protocol approved by the NIH Institutional Review Board. Neuropsychological testers were blind to PANSS ratings.

2.4 Statistical Analysis

Model comparisons were performed using CFA in Mplus (Muthén & Muthén, 1998–2007; www.statmodel.com). We did not individually analyze each factor structure derived in the literature. Rather, as noted, we counted the "votes" of the different studies for particular PANSS item-factor assignments. We then compared a model based on the original PANSS subscales with a sequence of five-factor models that varied by consistency of specific item-factor assignments in the literature review. The models tested ranged from a very inclusive model, reflecting any item-factor assignment appearing in at least 10 of the 29 factor analyses reviewed, to a more restrictive model including item-factor assignments that were consistent across at least 26 of the 29 reports. Items were missing in 0–2% of cases. Stereotyped thinking (N7) was missing most often. It was, however, included in only 19 of

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29 published models and only in the same factor 12 times. Tension (G4) met inclusion for two factors (Excited and Depressed) in one of our tested models. We assigned it to Depressed because it was assigned there most frequently.

We used a polychoric correlation matrix and full information estimation with a weighted least squares mean and variance adjusted method of CFA, which is appropriate for ordinal data (Flora & Curran, 2004). Models assessed by CFA are considered to have adequate fit when the Comparative Fit Index (CFI) and Non-Normed Fit Index (NNFI) are greater than 0.90 and the Root Mean Square Errors of Approximation (RMSEA) is less than 0.08 (Kline, 2010). CFI and NNFI are both included because, while CFI improves with greater model complexity, NNFI incorporates a penalty for each additional parameter. The AIC is included because it allows for comparison between models, with lower values indicating better relative fit.

Individual scores for each factor were calculated by dividing the sum of included item scores by the number of items in the factor. We also calculated Spearman correlations between scores on the new Positive and Negative factors with the broader Positive and Negative subscales.

To explore associations between symptoms and cognition, we calculated Spearman correlations between PANSS and cognitive variables. Cognitive performance was indexed using a four-subtest estimate of WAIS Full Scale IQ, as well as a composite score representing general cognitive ability ("g," see supplementary materials and Dickinson et al., 2011).

We explored whether our literature-derived factors differed with sex, as our main sample is 75% male.

2.5 Replication in a Novel Sample

We compared the original subscales with our preferred five-factor model in a distinct sample of 164 Japanese patients with schizophrenia (Ohi et al., 2011) (Table 2).

3. Results

3.1 Literature

The literature search yielded 29 five-factor models derived from apparently independent samples (Table 3). Of the 30 PANSS items, seven entered fewer than 20 models and only two had consistent assignment across all 29 models (Table 4).

3.2 Model

CFA demonstrated that the three-subscale model fit the data poorly (Table 5). Among the five-factor models, the most selective – including only 16 items – fit the data marginally better than more inclusive models. While fit statistics guided our choice, so did consistency of item-factor assignment in the literature. As there was a small natural break between items included in 22/29 models and in 24/29, we selected the 24/29 model. This model comprises 20 items categorized into Positive, Negative, Disorganized/Concrete, Excited, and Depressed factors. Factor loadings for individual items are strong, and bivariate correlations between factors are small (Tables 6 & 7). Four factors (all but Depressed) draw items from more than one original subscale.

We found strong factor-to-subscale correlations for Positive (r=0.90) and Negative (r=0.97) scales.

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CFA of our preferred model yielded adequate fit in the independent Japanese dataset (Table 5). Again, the three-subscales demonstrated poor fit.

3.3 Cognition and Demographics

All three original subscales correlated modestly but significantly with IQ and "g." In our model, the Disorganized/Concrete factor accounted for the largest share of the PANSS association with cognition (Table 8).

Consistent with previous research, males had higher Negative factor scores (F [df1,447]=1.443, p=0.027). Other factors did not differ significantly with sex.

4. Discussion

Current results contribute to the literature suggesting that five-factor models better represent the dimensional structure of PANSS data than the original three subscales. High correlations between original subscales and proposed factors for Negative and Positive symptoms suggest that the factors capture the essence of these critical symptom dimensions and, as in prior work, additional factors for Disorganized/Concrete, Excited and Depressed provide an empirically-based differentiation of other symptom dimensions. These results also offer a "consensus" model that might enhance comparability across studies. Across tested models, increasing selectivity yielded improved quantitative model fit. Psychometric and clinical considerations, however, favor retention of as many items as show reasonable consistency in their factor-assignment across the literature models, rather than overvaluation of small differences in fit indices. Some arbitrariness is unavoidable, but our proposed model appears to offer the best overall balance between good statistical fit and consistent factor-assignment. In sum, the proposed five-factor model offers psychometrically-coherent and relatively-discrete signals in Caucasian and Japanese samples.

Limitations of our work include, first, relatively small factors; two factors comprise only three items. Another issue is the exclusion from our preferred model of Suspiciousness/Persecution (P6) – a hallmark schizophrenia symptom. Including P6 consistently led to worse fit. This may reflect a clinical reality: paranoia can be present in various symptom configurations, and sometimes appears with few other major symptoms (American Psychiatric Association, 2000). P6 may simply represent a distinct symptom domain, only sparsely assessed by the PANSS.

The PANSS has recognized drawbacks, including reliance on limited behavioral observation for some items and patient report for others (Blanchard et al., 2011) and a vague ordinal rating metric (Cohen et al., 2008). In response, researchers are developing new symptom assessment methods. Although new measures will be valuable, many studies continue to collect PANSS data. It remains to be seen whether the five-factor model will supplant the traditional PANSS subscales in clinical practice. Much experience is required to determine how the factors compare with the subscales in relation to matters of clinical characterization and improvement with treatment, and whether the item groupings proposed here suit clinicians' preferences.

Although perhaps schizophrenia symptom dimensions could be adequately assessed with a briefer instrument, we do not advocate cutting items or other changes in PANSS administration. Given the strong likelihood of continued use of five-factor PANSS models in research, current analyses offer a possible compromise among slightly varying five-factor models that balances quantitative, psychometric and clinical considerations, and that might enhance comparisons across studies.

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Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Demographic information NIMH sample (n=458)

	Means
Age	34.8 ± 9.9
% Caucasian	81%
% Male	75%
Yrs. Education	14.1 ± 2.3
Acute Age	22.0 ± 5.6
WAIS IQ	92.2 ± 11.3
“g” (z-scores)	−1.27 ± 0.72

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Table 2

Demographic information Japanese sample (n=164)

	Means
Age	37.4 ± 11.5
% Male	55%
Yrs. Education	14.5 ± 2.2
Acute Age	23.9 ± 7.7

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Table 3

Published models included in analysis

Paper	Method: Rotation
Bell et al., 1994 (Bronx)	PCA: Equamax
Bell et al., 1994 (WHVA)	PCA: Equamax
Bunk et al., 1999	PCA: Varimax
Citrome et al., 2011	EFA: Varimax
Dollfus et al., 1995 (discharge)	PCA: Varimax
Drake et al., 2003 (final model)	PCA: Equamax
Dudek, 2005 (revised)	PCA: Varimax
Emsley et al., 2003	PCA: Equamax
Fredrikson et al., 1997	EFA: maximum likelihood
Fresán et al., 2005	PCA: Equamax
Higashima et al., 1998	PCA: Equamax
Kay & Sevy, 1990	PCA: Equamax
Lançon et al., 2000 (chronic)	PCA: Varimax
Lançon et al., 2000 (relapse)	PCA: Varimax
Lee et al., 2003	PCA: Equamax
Lépine, 1991	PCA
Levine & Rabinowitz, 2007	PCA: Promax
Lindenmayer et al. 1995a	PCA: Equamax
Lindenmayer et al. 1995b (wash-out)	PCA: Equamax
Lindstrom & von Knorring, 1993	PCA: Varimax
Lykouras et al. 2000	PCA: Varmiax; CFA
Marder et al., 1997 (placebo)	PCA: Equamax
Marder et al., 1997	PCA: Equamax
Marder et al., 1997 (risperidone)	PCA: Equamax
Mass et al., 2000 (haloperidol)	PCA: Equamax
van den Oord et al., 2006	PCA: Promax
van der Gaag et al., 2006b	10-Fold Cross Validation
White et al., 1997	CFA; EFA: Varimax
Wolthaus et al., 2000	PCA: Varimax, Equamax (and an unspecified Oblique method)

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Table 4

Literature summary showing how many times out of 29 published models each PANSS item loaded on each factor. Items included in the final preferred model are highlighted.

Symptom	Item	POSITIVE	NEGATIVE	DISORGANIZE D/CONCRETE	EXCITED	DEPRESSED
Delusions	**P1**	**29**				
Conceptual	**P2**	1		**27**		
Hallucinations Disorganization	**P3**	**26**		1	1	1
Excitement	**P4**			1	**27**	
Grandiosity	**P5**	**24**			3	
Suspiciousness/Persecut	**P6**	22			1	2
Hostility ion	**P7**				**29**	
Blunted Affect	**N1**		**28**			
Emotional Withdrawal	**N2**		**27**			
Poor Rapport	**N3**		**28**		2	1
Passive/Apathetic Social	**N4**		**27**			
Difficulty in Abstraction Withdrawal	**N5**		1	**27**		
Lack of Spontaneity	**N6**		**28**	1		
Stereotyped Thinking	**N7**	5		12	2	
Somatic Concern	**G1**	8			1	15
Anxiety	**G2**				1	**27**
Guilt Feelings	**G3**					**28**
Tension	**G4**			1	11	16
Mannerisms and	**G5**		3	18	1	
Depression Posturing	**G6**					**28**
Motor Retardation	**G7**		**24**	1		
Uncooperativeness	**G8**		3		**24**	
Unusual Thought	**G9**	**26**		3		
Disorientation Content	**G10**	1		21	2	1
Poor Attention	**G11**		2	**25**		1
Lack of Judgment and	**G12**	16		3	3	

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Symptom	Item	POSITIVE	NEGATIVE	DISORGANIZE D/CONCRETE	EXCITED	DEPRESSED
Disturbance of Volition Insight	**G13**		8	10		
Poor Impulse Control	**G14**		1		**27**	
Preoccupation	**G15**	3	2	12		6
Active Social Avoidance	**G16**	1	20		3	4

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Table 5

Confirmatory Factor Analysis Results

Model	df	Chi Square	AIC	CFI	RMSEA	NNFI	# items
Traditional PANSS 3-subfactor Model	**89**	**1416.03**	**1238.03**	**0.703**	**0.185**	**0.776**	**30**
Items included ≥10/29 models	96	534.69	342.69	0.902	0.102	0.931	30
Items included ≥15/29 models	86	503.28	331.28	0.908	0.105	0.934	27
Items included ≥20/29 models	69	390.84	252.84	0.929	0.103	0.948	23
Items included ≥21/29 models	66	326.97	194.97	0.943	0.095	0.957	22
Items included ≥23/29 models	62	299.37	175.37	0.950	0.093	0.962	21
Items included ≥24/29 models	**58**	**290.43**	**174.43**	**0.950**	**0.095**	**0.961**	**20**
Items included ≥25/29 models	45	175.79	85.79	0.972	0.081	0.978	17
Items included ≥26/29 models	40	126.02	46.02	0.981	0.070	0.985	16
Independent sample (≥24/29 model)	**43**	**153.81**	**67.81**	**0.941**	**0.127**	**0.975**	**20**
Independent sample 3-subfactor Model	50	984.27	884.27	0.517	0.344	0.787	30

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Table 6

Final Literature-Derived 5-Factor Model of the PANSS Standardized Estimates of Regression Weights

	Positive Factor	Negative Factor	Disorganized/Concrete Factor	Excited Factor	Depressed Factor	R^2
P1	0.84					0.71
P3	0.70					0.49
P5	0.74					0.55
G9	0.97					0.94
N1		0.84				0.71
N2		0.91				0.83
N3		0.85				0.72
N4		0.93				0.86
N6		0.84				0.71
G7		0.86				0.74
P2			0.85			0.72
N5			0.41			0.17
G11			0.80			0.64
P4				0.88		0.77
P7				0.89		0.79
G8				0.84		0.71
G14				0.69		0.48
G2					0.68	0.46
G3					0.73	0.53
G6					0.80	0.64

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Table 7

Final Literature-Derived 5-Factor Model of the PANSS factor correlations between factors

	Positive Factor	Negative Factor	Disorganized/Concrete Factor	Excited Factor	Depressed Factor
Positive Factor	1				
Negative Factor	0.191	1			
Disorg/Conc Factor	0.424	0.479	1		
Excited Factor	0.340	0.213	0.218	1	
Depressed Factor	0.280	0.066	0.100	0.238	1

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Table 8

Spearman correlations between original PANSS dimensions versus new PANSS factors and WAIS IQ and *g*

	Positive Dimension	Negative Dimension	General Psychopathology	Positive Factor	Negative Factor	Disorganiz d/Concrete Factor	Excited Factor	Depressed Factor
WAIS IQ	−0.187*	−0.293**	−0.160*	−0.102*	−0.236**	−0.347***	−0.161*	0.032
g	−0.208*	−0.263**	−0.191*	−0.105*	−0.196*	−0.403***	−0.167*	−0.001

*p < .05

**p < 5 E-5

***p< 5 E-10