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Testing the Psychopathology of Psychosis: Evidence for a General Psychosis Dimension

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Background: **Psychiatric taxonomists have sometimes argued for a unitary psychosis syndrome and sometimes for a pentagonal model, including 5 diagnostic constructs of positive symptoms, negative symptoms, cognitive disorganization, mania, and depression. This continues to be debated in preparation for impending revisions of the *Diagnostic and Statistical Manual of Mental Disorders* and the *International Classification of Diseases*. We aimed to identify general and specific dimensions underlying psychopathological features of psychosis.** ***Methods:*** **The samples comprised 309 patients admitted to psychiatric services in the acute phase of their first or second episode of psychosis and 507 patients with enduring psychosis recruited from community mental health teams. Patients' symptoms were assessed on the Positive and Negative Symptom Scale. Analyses compared unitary, pentagonal, and bifactor models of psychosis.** ***Results:*** **In both samples, a bifactor model including 1 general psychosis factor and, independently, 5 specific factors of positive symptoms, negative symptoms, disorganization, mania, and depression gave the best fit. Scores of general and specific symptom dimensions were differentially associated with phase of illness, diagnosis, social functioning, insight, and neurocognitive functioning.** ***Conclusions:*** **The findings provide strong evidence for a general psychosis dimension in both early and enduring psychosis. Findings further allowed for independent formation of specific symptom dimensions. This may inform the current debate about revised classification systems of psychosis.**

Key words: classification/DSM-V/dimensions/item response modeling/psychosis/schizophrenia

Introduction

Following Kraepelin's[1] distinction between dementia praecox/schizophrenia and manic depression, the classification of the psychoses has been a source of enduring discussion[2–5] and continues to be debated in preparation for impending revisions of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) and the *International Classification of Diseases* (ICD).[6,7] Some authors have argued for a unitary psychosis syndrome that encompasses Kraepelin's 2 major categories,[8] whereas others have argued for a pentagonal model, including 5 diagnostic constructs of positive symptoms, negative symptoms, cognitive disorganization, mania, and depression.[9] Both approaches point to commonalities across Kraepelin's 2 major categories, but 1 argues for fewer diagnostic constructs than those proposed by Kraepelin, whereas the other argues for more diagnostic constructs.

Any diagnostic construct requires a link with a phenotype that can be validly measured and that provides clinically useful information.[9] Both DSM and ICD systems, based on the categorical approach advocated by Kraepelin,[1] have evolved to include a large number of categories of psychosis in order to be exhaustive and, at the same time, mutually exclusive.[2] However, this categorical approach has been increasingly questioned on the grounds of high comorbidity between diagnoses, common etiological agents and the lack of zones of relative rarity between allegedly distinct categories.[2,6,7] Some authors have nonetheless argued that categorical representations of psychosis, despite limited validity, may still be of clinical utility if used in combination with dimensional indicators.[9,10]

It is now widely accepted that psychotic symptoms partition into several symptom dimensions.[11,12] While early research pointed toward 2 dimensions of positive and negative symptoms,[4] more recent factor analytic work has largely supported a pentagonal model that includes additional dimensions of cognitive disorganization, mania or excitement, and depression.[9–12] For instance, previous

studies on the dimensionality of 1 of the most widely used measures to assess psychotic symptoms, the Positive and Negative Symptom Scale (PANSS),[13] have produced fairly consistent evidence on 5 dimensions of psychosis.[12] Furthermore, attempts have been made to corroborate the validity of these dimensions through associations with clinical, neurocognitive, and social variables.[11] However, most of this research has focused on individuals with enduring psychosis, exposed to long periods of hospitalization and long-term antipsychotic treatment, with varying findings as to which symptoms are relevant to individual symptom dimensions.[13,14] So for example, as can be seen in online supplementary table S1, findings for the PANSS vary with respect to the magnitude of factor loadings of individual PANSS items on the 5 specific psychosis dimensions.[5,12,14–22] While several items have been found to be consistently related to a specific factor across studies, some items have been reported to be related to different factors.[12]

In contract, advocates of only 1 type of (unitary) psychosis have argued for 1 diagnostic construct encompassing symptoms of the 5 specific affective and nonaffective psychosis dimensions.[8] This approach has received increasing support from evidence suggesting that genetic and environmental risks are shared among affective and nonaffective psychotic disorders.[7] On this basis, recent recommendations for DSM-V even proposed replacing the large number of diagnostic constructs of psychosis with a general psychosis syndrome.[23] However, to date, there has been no attempt to use psychometric methods to determine whether there is a general psychosis dimension underlying the psychopathological features of affective and nonaffective psychosis.

In 2 large samples of patients with early (ie, first or second episode) and enduring psychosis, we aimed: (1) to examine whether there is a general psychosis dimension underlying psychopathological features of psychosis; (2) to investigate whether there are 5 specific psychosis dimensions of positive symptoms, negative symptoms, disorganization, mania, and depression; and (3) to explore the relationship of general and specific psychosis dimensions with phase of illness, diagnostic categories of established categorical classification systems (ie, ICD-10[24]/DSM-IV[25]), insight, social functioning, and neurocognition. We used item response modeling,[26] an emerging methodology, to study the dimensionality underlying psychopathological features of psychosis as rated by researchers on the PANSS. Item response models are statistical models of the relationship between characteristics of items (eg, item discrimination parameters), characteristics of individuals (eg, patients' standing on an underlying psychosis dimension), and the probability of an item response (eg, a rating of symptom severity on the PANSS).[26] This method allowed us, for the first time, to determine the extent to which severity ratings of psychotic symptoms can be explained by a general and/or 5 specific psychosis dimensions.

Methods

Sample

The early psychosis sample was taken from a multicenter randomized controlled trial (RCT), the SoCRATES study,[27] designed to assess the effect of cognitive-behavioral therapy on symptom reduction in patients in their first or second acute episode of psychosis. Patients were recruited from 11 mental health units in Manchester/Salford, Liverpool, and Nottinghamshire (UK) using the following inclusion criteria: (1) first or second acute admission to day/inpatient units; (2) DSM–IV[25] criteria for schizophrenia or related psychotic disorder; (3) positive symptoms for $\geq$4 weeks; (4) score of $\geq$4 on the PANSS[13] items for either delusions or hallucinations; and (5) no organic or substance misuse disorder. During the study period, 309 patients were recruited. Thirty-eight percent were involuntarily admitted, reflecting the fact that they were severely ill.

The enduring psychosis sample was obtained from a multicenter RCT, the DIALOG study,[28] designed to test a new computer-mediated intervention in patients with severe and enduring psychosis. The study was conducted in community mental health services in London (UK), Granada (Spain), Groningen (The Netherlands), Lund (Sweden), Mannheim (Germany), and Zurich (Switzerland) using the following inclusion criteria for patients: (1) living in the community and treated as outpatients ($\geq$3 mo of continuous care); (2) ICD-10[24] criteria for schizophrenia or related psychotic disorder (F20-F29); (3) aged between 18 and 65 years; (4) no organic or substance misuse disorder; (5) at least 1 meeting every 2 months with keyworker; and (6) expectation to continue with the service for the next 12 months. This sample comprised 507 patients diagnosed with schizophrenia or related psychotic disorder. More detailed information on the studies is available in Tarrier et al[27] and Priebe et al.[28]

Measures

Interviewers assessed patients' symptoms on the 30-item PANSS.[13] The scale was developed to assess the 3 main domains of positive, negative, and general symptoms. Each item is rated on a scale of 1–7 (with higher scores indicating more severe symptoms). Researchers received training in all rating procedures and achieved good interrater reliability in both the early (Cohen's kappa = 0.71) and enduring (Intraclass correlation coefficient = .72–.83) samples. In the DIALOG study, translated versions of the PANSS were used in the European centers. There is good evidence on the reliability and validity of the Spanish, Dutch, Swedish, and German versions of the PANSS.[20,21,29–31]

In the early psychosis sample, psychiatric diagnosis was made based on DSM-IV criteria for psychotic disorders.[25] In the enduring psychosis sample, ICD-10[24] diagnosis was obtained using the operationalized criteria checklist.[32]

Social functioning was assessed using the Social Functioning Scale,[33] an interview-based assessment in a wide range of domains, in the early psychosis sample. The Groningen Social Disability Schedule (GSDS)[34] was used to measure social functioning in the enduring psychosis sample. This schedule rates disabilities in 9 social roles with a sum score based on overall ratings. Good psychometric properties have been reported for the Spanish, English, Swedish, and German version of the GSDS,[35,36] which were used in Granada, London, Lund, and Mannheim/Zurich, respectively, in the DIALOG study.

The early psychosis sample also included measures of neuropsychological functioning and insight. The Hayling Sentence Completion Test[37] was used to assess patients' response suppression ability. This test comprises 2 sets of 15 sentences with the last word missing. In the A set patients have to complete the sentences, whereas in the B set sentences have to be completed with a nonsense ending word. Error scores for the B set,[37,38] indicative of impaired response suppression, were used in the present analyses. Insight was assessed using self-report insight scale of Birchwood et al,[39] which assesses the individual's belief that he/she suffers from a psychiatric disorder requiring treatment. Response suppression ability and insight were not assessed in the enduring psychosis sample.

Statistical Analysis

Model estimation used the full-information maximum likelihood (ML) estimator with robust SEs in MPlus, Version 5.2.[40] This estimator returns coefficients from a full-information item factor model equivalent to a 2 parameter logistic item response model extended to polytomous items. Data were assumed to be missing at random, which allowed for inclusion of the full samples. Model fit was examined using the log-likelihood (LL), the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and the sample-size adjusted BIC (aBIC).[41] Lower values than for the comparison model indicate better model fit and a difference in these indices of 10 is considered important.[41] We also computed -2 times the LL difference ($-2[\Delta LL]$) to test differences in model comparisons for statistical significance.[42] We probed these analyses further to assess overall model fit of the best-fitting model using the root mean square error of approximation (RMSEA)[43] by repeating model estimation with the limited-information ML estimator in a sensitivity analysis.

Path diagrams of the 4 alternative latent variable models that were estimated to examine whether there is a general psychosis dimension and, in addition, whether there are specific dimensions of positive symptoms, negative symptoms, disorganization, mania, and depression are shown in online supplementary figure S1. Model A denotes a simple unidimensional model with 1 general factor explaining all severity ratings on the PANSS, consistent with the model of unitary psychosis.[8] Model B is a multidimensional model with 5 uncorrelated specific factors for the specific psychosis dimensions. Model C refers to a multidimensional model with correlated specific factors for each specific psychosis dimension. Models B and C are in line with the pentagonal model of psychosis, as described by Van Os and Kapur,[9] with varying assumptions about whether or not the dimensions are correlated. Model D denotes a bifactor model with 1 general factor independent from uncorrelated (orthogonal) specific factors. The bifactor model constrains each item to have a nonzero loading on a general dimension (ie, psychosis) underlying all ratings on the PANSS and a nonzero loading on a specific dimension that only accounts for PANSS ratings of a particular domain (eg, positive symptoms).[42] While, in this model, general dimensions are conceptually broader (more general) than specific dimensions (which tend to be more conceptually narrow), the probability of a rating depends on both dimensions. Hence, the model provides information on the extent to which ratings can be explained by general (ie, psychosis) vs specific dimensions (eg, positive symptoms). That is, it determines whether specific dimensions provide information that is nonredundant with the general dimension.[42] This modeling approach allowed us to examine whether there is, in plain words, a "thing" such as psychosis (model A) or positive symptoms (models B/C) or both (model D) that explains the severity of psychotic symptoms as rated by the PANSS.

As can be seen in online supplementary table S1, findings from previous studies on the dimensionality of the PANSS vary with regard to the magnitude of factor loadings of individual items on specific psychosis dimensions.[5,12,14–22] While several items have been found to be consistently related to a specific factor across studies, some items have been reported to be related to different factors.[12] Therefore, we sought to compare and test the factor solutions reported by published studies with sufficiently large samples (ie, $n > 240$)[12] (see online supplementarytable S1). Hence, the specific factors included into models B, C, and D were specified in line with factors from previous studies on which PANSS items had their highest loading. For instance, in the Kay and Sevy[16] study, items on delusions, hallucinatory behavior, grandiosity, unusual thought content, and lack of judgment and insight had the highest factor loadings on the positive symptom factor. For this reason, a specific factor accounting for ratings of these items was included in models B, C, and D. By comparison, Lindemayer et al[5] additionally reported suspiciousness to load highest on this factor. Therefore, models B, C, and D were amended to additionally estimate a loading for this item on the specific factor for positive symptoms. This procedure was repeated for all factor solutions observed in previous studies.

The 4 alternative latent variable models were compared on the basis of model fit and the magnitude of the factor loadings. Comparison of model fit indices across models was aimed at testing: first, whether there was a general psychosis dimension that explained

Table 1. Basic Sociodemographic and Clinical Characteristics

	Enduring Psychosis Sample (DIALOG)	Early Psychosis Sample (SoCRATES)
Age (y)[a], mean (SD)	42.2 (11.4)	29.8 (10.4)
Gender, *n* (%)		
Male	336 (66.3)	216 (69.9)
Female	171 (33.7)	93 (30.1)
Center, *n* (%)		
London (UK)	99 (19.5)	—
Liverpool (UK)	—	114 (36.9)
Manchester/Salford (UK)	—	112 (36.2)
North Nottinghamshire (UK)	—	83 (26.9)
Granada (Spain)	88 (17.4)	—
Groningen (Netherlands)	99 (19.5)	—
Lund (Sweden)	61 (12.0)	—
Mannheim (Germany)	83 (16.4)	—
Zurich (Switzerland)	77 (15.2)	—
Length of illness (y)[b], mean (SD)	15.9 (10.3)	0.10 (0.32)
Diagnosis, *n* (%)		
Schizophrenia	354 (69.8)	123 (39.8)
Schizoaffective disorder	73 (14.4)	39 (12.6)
Delusional disorder	3 (.59)	25 (8.1)
Schizophreniform disorder	—	109 (35.3)
Psychotic disorder NOS	77 (15.2)	13 (4.2)

Note: Missing values: length of illness, 42 years. NOS, not otherwise specified.
[a]1.
[b]42.

associations among all PANSS items independent from specific dimensions (models A and D vs models B and C), and second, whether, in addition to a general psychosis dimension, the formation of specific psychosis dimensions was justified (model A vs B, C, and D).

Factor loadings (equivalent to item discrimination parameters in the 2 parameter logistic item response model) were computed to examine the extent to which PANSS items discriminated between patients with higher and lower levels on the underlying general and specific psychosis dimensions. In other words, factor loadings were used to assess the extent to which a particular psychotic symptom (eg, hallucinatory behavior) was related to the general and/or specific psychosis dimension. In order to maximize the precision of estimated factor loadings, these were computed in the pooled sample of $n = 816$ patients. Finally, factor scores were computed and regressed on clinical, neurocognitive, and social factors as well as sum scores of PANSS items with high factor loadings ($\lambda \geq .35$).

Results

Basic Sample Characteristics

Basic characteristics of the early and enduring psychosis samples are summarized in table 1. The mean age of patients was 29.8 and 42.2 years, respectively. In both samples, patients were predominantly male and mostly had a diagnosis of schizophrenia or schizophreniform disorder. In contrast to the early psychosis sample, patients in the enduring psychosis sample had a long history of illness.

General and Specific Psychosis Dimensions

Table 2 shows model fit statistics for unidimensional, multidimensional, and bifactor models in the early and enduring psychosis samples. The bifactor model matched the sample data better than unidimensional and multidimensional models in both samples. The best-fitting bifactor model included 1 general psychosis factor and 5 specific factors as found by Emsley et al.[12] The differences in model fit of the bifactor model in comparison to unidimensional and multidimensional models were statistically significant (enduring psychosis sample: $-2(\Delta LL_{a,d}) = 1396.36$, $df = 30$, $P < .001$; $-2(\Delta LL_{b,d}) = 915.78$, $df = 30$, $P < .001$; $-2(\Delta LL_{c,d}) = 144.64$, $df = 20$, $P < .001$ and early psychosis sample: $-2(\Delta LL_{a,d}) = 867.58$, $df = 30$, $P < .001$; $-2(\Delta LL_{b,d}) = 494.74$, $df = 30$, $P < .001$; $-2(\Delta LL_{c,d}) = 244.1$, $df = 20$, $P < .001$). Sensitivity analyses showed that overall model fit was good in both the enduring (RMSEA = .08) and early psychosis sample (RMSEA = .08).

Relationship of Psychotic Symptoms With General and Specific Psychosis Dimensions

Pooled factor loadings of the best-fitting bifactor model including 1 general and 5 specific factors are summarized in table 3. For most PANSS items, factor loadings of $\lambda \geq .35$ were observed on the general factor. With regard to specific psychosis dimensions, delusions, grandiosity, and unusual thought content were most strongly related to the underlying positive symptom dimension. Furthermore, the symptoms of blunted affect, emotional withdrawal, poor rapport, passive social withdrawal, lack of spontaneity, and motor retardation highly loaded on the negative symptom dimension. On the disorganization dimension, conceptual disorganization, difficulty in abstract thinking, mannerisms and posturing, and poor attention were most informative. The symptoms of hostility and poor impulse control most strongly related to the mania dimension. Last, items on anxiety, guilt feelings, tension, and depression were most strongly associated with the depression dimension.

Factors Associated With General and Specific Psychosis Dimensions

Table 4 and online supplementary figure S2 show findings on factors associated with scores of general and specific psychosis dimensions.

Compared with patients with a first-psychotic episode, patients with a second episode did not differ in scores of the general psychosis dimension. However, patients with enduring psychosis had significantly lower scores. There

Table 2. Model Fit Statistics for Unitary (Unidimensional), Pentagonal (Multidimensional), and Bifactor Models in Enduring Psychosis Sample

	Enduring Psychosis Sample (DIALOG)					Early Psychosis Sample (SoCRATES)				
	LL	FP	AIC	BIC	aBIC	LL	FP	AIC	BIC	aBIC
Model A	−18 484.84	187	37 343.69	38 132.94	37 539.39	−13 316.31	194	27 020.63	27 744.27	27 128.98
Kay and Sevy[16]										
Model B	−18 296.62	186	36 965.23	37 750.26	37 159.88	−13 235.91	193	26 857.82	27 577.73	26 965.61
Model C	−18 102.27	196	36 596.54	37 423.77	36 801.65	−13 117.23	203	26 640.46	27 397.67	26 753.84
Model D	−17 837.35	216	36 106.70	37 018.35	36 332.74	−12 958.51	223	26 363.01	27 194.82	26 487.56
Lindenmayer et al[5]										
Model B	−18 166.33	187	36 706.66	37 495.91	36 902.36	−13 184.34	194	26 756.67	27 480.31	26 865.03
Model C	−17 901.03	197	36 196.05	37 027.51	36 402.21	−13 039.86	204	26 487.711	27 248.65	26 601.65
Model D	−17 813.65	217	36 061.29	36 977.16	36 288.39	−12 926.73	224	26 301.45	27 136.99	26 426.56
Marder et al[19]										
Model B	−18 126.56	187	36 627.12	37 416.37	36 822.81	−13 142.64	194	26 673.27	27 396.91	26 781.63
Model C	−17 925.66	197	36 245.32	37 076.78	36 451.49	−12 986.57	204	26 381.14	27 142.08	26 495.07
Model D	−17 806.53	217	36 047.06	36 962.93	36 274.15	−12 884.36	224	26 216.76	27 052.26	26 341.82
White et al[20]										
Model B	−18 557.72	182	37 479.45	38 247.59	37 669.91	−13 311.16	189	27 000.32	27 705.30	27 105.88
Model C	−18 212.36	192	36 808.71	37 619.06	37 009.64	−13 159.12	199	26 716.28	27 458.57	26 827.42
Model D	−17 891.61	212	36 207.21	37 101.98	36 429.07	−12 977.79	219	26 393.57	27 210.47	26 515.89
Lancon et al[17]										
Model B	−18 175.62	187	36 725.25	37 514.50	36 920.95	−13 141.06	194	26 670.12	27 393.76	26 778.47
Model C	−17 956.41	197	36 306.81	37 138.27	36 512.98	−13 018.46	204	26 444.92	27 205.86	26 558.86
Model D	−17 820.74	217	36 075.48	36 991.35	36 302.58	−12 926.80	224	26 301.60	27 137.15	26 426.71
Lancon et al[18]										
Model B	−18 425.82	181	37 213.64	37 977.57	37 403.06	−13 310.37	188	26 996.75	27 698.00	27 101.75
Model C	−18 276.28	191	36 934.57	37 740.70	37 134.45	−13 207.41	198	26 810.81	27 549.37	26 921.40
Model D	−17 850.46	211	36 122.92	37 013.46	36 343.73	−12 954.21	218	26 344.41	27 157.57	26 466.17
Lykouras et al[21]										
Model B	−18 352.71	186	37 077.41	37 862.44	37 272.06	−13 162.16	193	26 710.32	27 430.23	26 818.12
Model C	−18 001.45	196	36 394.89	37 222.13	36 600.01	−13 036.93	203	26 479.86	27 237.07	26 593.24
Model D	−17 836.06	216	36 104.13	37 015.78	36 330.17	−12 929.60	223	26 305.19	27 137.01	26 429.74
Mass et al[22]										
Model B	−18 605.70	179	37 569.39	38 324.88	37 756.72	−13 411.90	186	27 195.80	27 889.60	27 299.69
Model C	−18 472.14	189	37 322.28	38 119.97	37 520.07	−13 316.13	196	27 024.26	27 755.36	27 133.73
Model D	−17 947.56	209	36 313.13	37 195.23	36 531.85	−13 029.45	216	26 490.89	27 296.59	26 611.53
Emsley et al[14]										
Model B	−18 244.55	187	36 797.10	37 586.35	36 992.80	−13 129.89	194	26 647.78	27 371.42	26 756.13
Model C	−17 858.98	197	36 111.970	36 943.42	36 318.13	−13 004.57	204	26 417.13	27 178.07	26 531.07
Model D	−17 786.66	217	36 007.320	36 923.18	36 234.41	−12 882.52	224	26 213.03	27 048.57	26 338.14
Van den Oord et al[23]										
Model B	−18 893.75	179	38 145.50	38 900.98	38 332.82	−13 418.85	186	27 209.70	27 903.50	27 313.58
Model C	−18 599.27	189	37 576.55	38 374.24	37 774.34	−13 279.92	196	26 951.85	27 682.95	27 061.32
Model D	−18 051.63	209	36 521.27	37 403.37	36 739.99	−13 053.02	216	26 538.04	27 343.74	26 658.68
Levine and Rabinowitz[24]										
Model B	−18 338.82	184	37 045.64	37 822.22	37 238.19	−13 216.87	191	26 815.74	27 528.19	26 922.42
Model C	−18 043.48	194	36 474.96	37 293.76	36 677.99	−13 103.36	201	26 608.72	27 358.47	26 720.98
Model D	−17 801.63	214	36 031.25	36 934.46	36 255.20	−12 942.83	221	26 327.66	27 152.01	26 451.09

Note: Model A, unitary (unidimensional) psychosis model with 1 general factor; Model B, pentagonal (multidimensional) model with 5 uncorrelated specific factors; Model C, pentagonal (multidimensional) model with 5 correlated specific factors; Model D, bifactor model with 1 general and 5 uncorrelated specific factors; LL, Log-likelihood; FP, Free Parameters; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; aBIC, adjusted Bayesian Information Criterion.

were no significant differences in scores of the general psychosis dimension between subjects with schizophrenia compared with those with schizoaffective disorder (see online supplementary figure S2a). Furthermore, the general psychosis dimension was negatively associated with social functioning. There was also a strong positive association of factor scores with sum scores of PANSS items.

On the positive symptom dimension, patients with enduring psychosis had significantly lower scores than patients with early psychosis. Compared with patients with schizophrenia, those with delusional and schizophreniform

Table 3. Factor Loadings in Bifactor (Integrated) Model of Psychosis in Pooled Sample (n = 816)

		Pooled Factor Loadings					
Items	Variable	General	Positive symptoms	Negative symptoms	Disorganization	Mania	Depression
Delusions	P1	0.70 (0.01)***	0.52 (0.01)***				
Hallucinatory behavior	P3	0.51 (0.04)***	0.26 (0.05)***				
Grandiosity	P5	0.27 (0.04)***	0.37 (0.07)***				
Suspiciousness	P6	0.65 (0.03)***	0.33 (0.04)***				
Unusual thought content	G9	0.63 (0.03)***	0.47 (0.04)***				
Lack of judgment and insight	G12	0.56 (0.03)***	0.32 (0.04)***				
Blunted affect	N1	0.23 (0.04)***		0.79 (0.01)***			
Emotional withdrawal	N2	0.36 (0.04)***		0.72 (0.03)***			
Poor rapport	N3	0.47 (0.04)***		0.61 (0.04)***			
Passive social withdrawal	N4	0.49 (0.04)***		0.47 (0.04)***			
Lack of spontaneity	N6	0.32 (0.04)***		0.72 (0.03)***			
Motor retardation	G7	0.09 (0.04)*		0.70 (0.03)***			
Disturbance of volition	G13	0.65 (0.03)***		0.16 (0.04)***			
Active social avoidance	G16	0.61 (0.04)***		0.22 (0.04)***			
Conceptual disorganization	P2	0.48 (0.04)***			0.59 (0.02)***		
Difficulty in abstract thinking	N5	0.47 (0.04)***			0.45 (0.05)***		
Stereotyped thinking	N7	0.70 (0.03)***			0.14 (0.04)**		
Mannerisms and posturing	G5	0.37 (0.04)***			0.35 (0.05)***		
Disorientation	G10	0.59 (0.04)***			0.33 (0.06)***		
Poor attention	G11	0.58 (0.04)***			0.48 (0.05)***		
Preoccupation	G15	0.76 (0.03)***			0.07 (0.04)***		
Excitement	P4	0.53 (0.04)***				0.33 (0.04)***	
Hostility	P7	0.56 (0.04)***				0.50 (0.07)***	
Uncooperativeness	G8	0.69 (0.03)***				0.33 (0.06)***	
Poor impulse control	G14	0.68 (0.03)***				0.40 (0.05)***	
Somatic concern	G1	0.30 (0.04)***					0.24 (0.05)***
Anxiety	G2	0.46 (0.04)***					0.55 (0.04)***
Guilt feelings	G3	0.28 (0.04)***					0.39 (0.05)***
Tension	G4	0.48 (0.04)***					0.45 (0.04)***
Depression	G6	0.42 (0.04)***					0.44 (0.04)***

disorder scored significantly higher (see online supplementary figure S2b). Furthermore, this dimension was negatively associated with insight and had a strong positive association with PANSS sum scores.

Factor scores of the negative symptom dimension were significantly higher in patients with enduring psychosis. Patients with schizoaffective, delusional, and schizophreniform disorder scored significantly lower than those with schizophrenia (see online supplementary figure S2c). In both early and enduring psychosis patients, this dimension was inversely related to social functioning. Higher factor scores were strongly associated with higher PANSS sum scores.

We found no differences between early and enduring psychosis patients in disorganization scores. Disorganization scores were significantly lower in patients with delusional and schizophreniform disorder compared with those with schizophrenia (see online supplementary figure S2c). Also, patients with higher PANSS sum scores and more pronounced impairment in their response suppression ability scored significantly higher.

Compared with early psychosis patients, patients with enduring psychosis had significantly lower mania scores. While patients with schizoaffective disorder had higher mania scores than those with schizophrenia, this difference fell short of statistical significance (see online supplementary figure S2d). Higher mania scores were significantly associated with lower insight ratings and higher PANSS sum scores.

On the depression dimension, there were no differences across illness phases. Compared with patients with schizophrenia, those with schizoaffective disorder and psychotic disorder not otherwise specified (NOS) scored significantly higher on this dimension. Patients with higher depression scores also had significantly higher PANSS sum scores and greater insight.

Discussion

This is the first study to date to investigate general and specific psychosis dimensions in 2 large samples of early and enduring psychosis. We found strong evidence of a general psychosis dimension underlying psychopathological features of positive and negative symptoms, disorganization, mania, and depression. Furthermore, there were sufficiently strong specific factors to allow for formation of

Table 4. Regression of Factor Scores of General and Specific Psychosis Dimensions on Clinical, Neurocognitive, and Social Factors

	General			Positive Symptoms			Negative Symptoms			Disorganization			Mania			Depression		
	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*
Pooled sample																		
Phase of illness, first episode vs second episode	–.02	–0.24 (–0.80 to 0.33)	.406	–.001	–0.01 (–0.41 to 0.40)	.976	.03	0.31 (–0.33 to 0.94)	.337	–.03	–0.17 (–0.54 to 0.20)	.370	.04	0.07 (–0.07 to 0.22)	.315	.01	0.01 (–0.09 to 0.12)	.806
Enduring psychosis	–.64	–3.21 (–3.49 to –2.93)	<.001	–.33	–0.96 (–1.16 to –0.75)	<.001	.24	1.07 (0.75 to 1.39)	<.001	.05	0.11 (–0.07 to 0.30)	.226	–.20	–0.20 (–0.28 to –0.13)	<.001	–.004	–0.003 (–0.06 to 0.05)	.924
Diagnosisa, schizophrenia vs schizoaffective disorder	.03	0.19 (–0.29 to 0.66)	.439	–0.03	–0.11 (–0.40 to 0.18)	.459	–.10	–0.66 (–1.09 to –0.22)	.003	.01	0.04 (–0.21 to 0.29)	.751	.05	0.08 (–0.02 to .18)	.131	.11	0.11 (0.04 to 0.18)	.003
Delusional disorder	.07	0.94 (0.07 to 1.82)	.035	.11	0.88 (0.34 to 1.41)	.001	–.13	–1.56 (–2.37 to –0.76)	<.001	–.14	–0.94 (–1.41 to –0.47)	<.001	.03	0.08 (–0.10 to 0.27)	.388	.05	0.09 (–0.05 to 0.22)	.194
Schizophreniform disorder	.27	1.93 (1.46 to 2.41)	<.001	.14	0.59 (0.30 to 0.89)	<.001	–.18	–1.15 (–1.59 to –0.71)	<.001	–.07	–0.26 (–0.51 to –0.002)	.048	.15	0.21 (0.11 to 0.31)	<.001	.05	0.05 (–0.02 to 0.13)	.143
Psychotic disorder NOS	–.16	–1.21 (–1.73 to –0.70)	<.001	–.08	–0.37 (–0.68 to –0.05)	.022	.06	0.38 (–0.09 to 0.86)	.112	–.01	–0.04 (–0.32 to 0.23)	.753	–.03	–0.05 (–0.16 to 0.06)	.394	.12	0.13 (0.05 to 0.21)	.001
PANSS sum scores[a]																		
General	.96	0.123 (0.120 to 0.125)	<.001															
Positive symptoms				.70	0.25 (0.23 to 0.27)	<.001												
Negative symptoms							.89	0.32 (0.31 to 0.33)	<.001									
Disorganization										.75	.23 (0.22 to 0.25)	<.001						
Mania													.66	0.17 (0.16 to 0.18)	<.001			
Depression																.79	0.069 (0.066 to 0.073)	<.001
Early psychosis sample (SoCRATES)																		
Social Functioning	–.22	–0.01 (–0.02 to –0.005)	.001	.13	0.004 (–0.001 to 0.01)	.052	–.16	–0.01 (–0.02 to –0.002)	.015	.10	0.004 (–0.001 to 0.01)	.122	.02	0.0003 (–0.002 to 0.002)	.725	.07	0.001 (–0.001 to 0.002)	.280

Table 4. Continued

	General			Positive Symptoms			Negative Symptoms			Disorganization			Mania			Depression		
	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*	β	*B* (95% CI)	*P*
Insight	–.01	–0.003 (–0.06 to 0.05)	.893	–.25	–0.07 (–0.11 to –0.04)	<.001	.04	0.02 (–0.04 to 0.09)	.502	–.28	–0.08 (–0.12 to –0.05)	<.001	–.18	–0.02 (–0.04 to –0.01)	.005	.29	0.02 (0.01 to 0.03)	<.001
Neurocognitive functioning	.02	0.002 (–0.02 to 0.02)	.758	–.03	–0.003 (–0.02 to 0.01)	.666	.01	0.002 (–0.02 to 0.03)	.870	.13	0.01 (0.001 to 0.03)	.049	–.07	–0.003 (–0.01 to 0.003)	.303	.06	0.002 (–0.10 to 0.04)	.350
Enduring psychosis sample (DIALOG)																		
Social functioning	–.63	–0.31 (–0.36 to –0.25)	<.001	.03	0.01 (–0.04 to 0.06)	.654	–.43	–0.24 (–0.32 to –0.17)	<.001	–.09	–0.03 (–0.08 to 0.02)	.242	–.01	–0.001 (–0.02 to 0.02)	.873	–.03	–0.003 (–0.02 to 0.01)	.686

Note: PANSS, Positive and Negative Symptom Scale; NOS, not otherwise specified.
[a]Sum scores of PANSS items with high discriminative ability according to factor loadings shown in table 3.

specific dimensions of positive symptoms, negative symptoms, disorganization, mania, and depression. Last, general and specific psychosis dimensions were differentially associated with phase of illness, diagnosis, insight, social functioning, insight, and response suppression ability.

Methodological Considerations

The main strengths of our study were that we replicated findings by fitting alternative latent variable models in 2 large samples of enduring and early psychosis. We assessed psychotic symptoms with 1 of the most widely used and extensively studied measures, the PANSS. Furthermore, item response modeling was used to examine the dimensionality underlying psychopathological features of psychosis. This allowed us to identify variance driven by a general psychosis dimension independent from variance due to specific psychosis dimensions.

However, there are a number of limitations that should temper any conclusions that may be drawn from our study. First, we drew on existing data to address the aims of this study. This did not allow for a priori selection of social, clinical, and neurocognitive measures. Multiple measures of symptom severity would have allowed us to disentangle method from substantive conceptual variance. Also, samples did not include individuals with affective, substance-induced, and organic psychosis nor specific measures of genetic or environmental risk. This would have helped to more fully elucidate the validity of general and specific psychosis dimensions and test whether these hold in bipolar disorder and psychotic depression. Furthermore, the diagnostic categories of schizophreniform and delusional disorder included only, or at least mostly, patients with early psychosis. Hence, differences in general psychotic, positive, and manic symptom dimensions between these categories and schizophrenia were most likely due to differences found across illness phases. In addition, data were not collected prospectively, so we were unable to shed light on the dynamics of the clinical picture or test the longitudinal measurement invariance of the bifactor structure. However, convergence of the findings on model fit statistics did suggest equivalent factorial solutions across early and enduring psychosis. When considered in the context of model parsimony, the model that gave the best fit in terms of LL index included more freely estimated parameters than the alternative models examined in this study. However, according to AIC, BIC, and aBIC, information indices that seek to adjust for model complexity,[41] the bifactor model still gave the best model fit. It may also be argued that contemporary conceptualizations of, and previous empirical research on, psychosis imply a heterogeneous diagnostic construct of psychosis that inevitably requires testing less parsimonious models.

Comparisons With Previous Research

In recent years, there has been increasing evidence from large population-based studies suggesting that genetic

and environmental effects are partly shared among affective and nonaffective psychoses.[7] However, to date, there has been no evidence as to whether there is a measurable phenotype of general psychosis encompassing affective and nonaffective symptoms.[23] Our study is the first to support a general psychosis dimension underlying psychopathological features of psychosis that can be validly measured. On the spectrum from affective to nonaffective psychosis, in our study, patients with schizoaffective disorder were closest to the affective end. Intriguingly, in both early and enduring psychosis, we found an absence of differences on the general psychosis dimension between schizoaffective disorder and schizophrenia. This finding suggests that, in contrast to Kraepelin's[1] distinction between affective and nonaffective psychosis, the general psychosis dimension may hold across symptoms of both diagnostic constructs. Of course, this will need to be verified on further samples that include patients diagnosed as suffering from affective psychosis.

In addition to a general psychosis dimension, we found evidence on 5 specific dimensions. Echoing previous studies, these included positive and negative symptoms, disorganization, mania, and depression.[5,12,14–22] However, in contrast to earlier reports with varying findings as to which symptoms are relevant to individual symptom dimensions, in 2 independent samples of early and enduring psychosis, we found that the specific psychosis dimensions as reported by Emsley et al[12] best explained symptom ratings on the PANSS. In this respect, our study moved beyond previous research, in that findings on specific psychosis dimensions that we observed in individuals with enduring psychosis, exposed to long periods of hospitalization and long-term antipsychotic treatment, were directly replicated in individuals in the acute phase of their first or second episode.

The validity of general and specific psychosis dimensions was further corroborated by evidence of differential associations with clinical and social variables. In line with findings on the course of psychosis,[44] there was evidence that general psychotic, positive, and manic symptoms were more, but negative symptoms less pronounced in early than enduring psychosis. One potential explanation of these differences is that the general, positive, and manic symptoms are related to hyperdopaminergia, which has been found to be more pronounced in early psychosis.[45] Furthermore, consistent with evidence on a substantial decline in functioning after 5–10 years of experiencing psychotic symptoms,[44] associations of social functioning with general psychosis and negative symptom dimensions were stronger in enduring than early psychosis.

In line with operational definitions of ICD-10[24] and the current version of DSM-V,[46] the validity of the positive symptom dimension, on which PANSS ratings of delusions, unusual thought content, and grandiosity discriminated best between patients, was supported by findings on higher scores in patients with delusional disorder than with schizophrenia or schizoaffective disorder. Adding to this, the association that we found between lower insight and higher positive symptoms was consistent with previous research.[47] Also echoing operational definitions of ICD-10[24] and DSM-V,[46] disorganization scores were significantly less pronounced in patients with delusional and schizophreniform disorder compared with those with schizophrenia. The validity of this dimension was further corroborated by evidence consistent with Nathaniel-James and Frith[38] that patients with more pronounced impairment in their response suppression ability were more disorganized.

Intriguingly, even though scores of the mania dimension were higher in schizoaffective disorder than schizophrenia, this difference was not statistically significant. One reason for the absence of differences across these diagnostic categories might be that the mania dimension does not tap the core affective symptoms of elevation of mood included in operational definitions of schizoaffective disorder[24,46] but rather aspects of excitement and irritability.[12] Nevertheless, consistent with findings on the relationship between insight and mania,[47] patients scoring higher on this dimension had significantly lower insight ratings. By comparison, patients with schizoaffective disorder scored significantly higher than schizophrenia patients on the depression dimension. On this dimension, PANSS ratings of guilt feelings, tension, and depression, which are included in operational definitions of schizoaffective disorder (depressive type),[24,46] discriminated strongly between patients. Echoing findings by Aspiazu et al,[47] patients with higher depression scores also had significantly greater insight.

Implications

Our finding of a general psychosis dimension that can be validly measured in both early and enduring psychosis may inform the current debate about revised classification systems of psychosis.[6,7,23] It provides evidence suggestive, though not conclusive, of a syndrome encompassing affective and nonaffective symptoms of psychosis. However, the finding requires careful replication in samples of affective, substance-induced, and organic psychosis before firm conclusions can be drawn as to whether all psychotic disorders should be classified in one unified psychosis chapter. Until then, evidence on a general psychosis dimension remains restricted to the here studied schizophrenia spectrum disorders, which are grouped together in the current version of DSM-V.[46] Furthermore, we did not find evidence that would justify "replacing" specific diagnostic constructs of psychosis with a general psychosis syndrome, as has been recently suggested.[23] Rather, findings allowed for independent formation of specific symptom dimensions.

Current diagnostic constructs have limited validity and the development of empirically grounded classifications

Table 5. Potential Use of (Integrated) Bifactor Model for Diagnosis and Treatment Decisions

Dimension	DSM-V Diagnostic Category	PANSS Items[a]	Treatment Decisions (Examples)
General	Schizophrenia spectrum and other psychotic disorders, bipolar and related disorders, depressive disorders	Delusions (P1), hallucinatory behavior (P3), suspiciousness (P6), unusual thought content (G9), lack of judgment and insight (G12), emotional withdrawal (N2), poor rapport (N3), passive social withdrawal (N4), disturbance of volition (G13), active social avoidance (G16), conceptual disorganization (P2), difficulty in abstract thinking (N5), stereotyped thinking (N7), mannerisms and posturing (G5), disorientation (G10), poor attention (G11), preoccupation (G15), excitement (P4), hostility (P7), uncooperativeness (G8), poor impulse control (G14), anxiety (G2), tension (G4), and depression (G6)	Antipsychotic drugs[7,9,48]
Positive symptoms	Schizophrenia spectrum and other psychotic disorders, bipolar and related disorders	Delusions (P1), grandiosity (P5), and unusual thought content (G9)	Antipsychotic drugs,[7,9,48] cognitive behavioral therapy[9,48]
Negative symptoms	Schizophrenia spectrum and other psychotic disorders	Blunted affect (N1), emotional withdrawal (N2), poor rapport (N3), passive social withdrawal (N4), lack of spontaneity (N6), motor retardation (G7)	Arts therapy[48]
Disorganization	Schizophrenia spectrum and other psychotic disorders	Conceptual disorganization (P2), difficulty in abstract thinking (N5), mannerisms and posturing (G5), and poor attention (G11)	Cognitive remediation[49]
Mania	Bipolar and related disorders (with psychotic features)	Hostility (P7) and poor impulse control (G14)	Lithium, antipsychotic drugs[7]
Depression	Major depressive disorder (with psychotic features); bipolar and related disorders (with psychotic features)	Anxiety (G2), guilt feelings (G3), tension (G4), and depression (G6)	Antidepressant drugs, Lithium[7]

Note: DSM-V, *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*; PANSS, Positive and Negative Symptom Scale.
[a]Sum scores of PANSS items with high discriminative ability according to factor loadings shown in table 3 may be used as crude proxies of the underlying general and specific psychosis dimensions.

can only improve this situation. The integrated bifactor model of psychosis, the validity of which we have tested in this study, may have considerable utility with regard to diagnosis and treatment, although this needs to be established by future research. General and specific dimensions of this model may be used as dimensional indicators that provide diagnostic information at different levels of generality, with differential implications for treatment decisions. The potential use of these dimensions, in combination with the current version of DSM-V, in clinical practice is illustrated in table 5.

One possibility would be to treat clinical decision-making as a hierarchical process with the general psychosis dimension providing diagnostic information about whether individuals qualify for a diagnosis of any psychotic disorder (vs other disorders). Given that antipsychotic drugs may reduce psychotic experiences across diagnostic categories,[7,9,48] high scores on the general dimension may indicate treatment with these drugs (if treatment response for this dimension can be established by future research). In a second step, specific dimensions of positive symptoms, negative symptoms, cognitive disorganization, mania or excitement, and depression may then be used as indicators of whether individuals qualify for a diagnosis of a specific diagnosis. For instance, in line with Van Os and Kapur,[9] patients scoring high on the dimensions of positive symptoms, negative symptoms, and disorganization may have an increased probability of qualifying for a schizophrenia diagnosis, whereas patients with a diagnosis of bipolar disorder are likely to score high on the positive symptom and mania dimension. There may be differential implications for treatment decisions. For example, it is possible that there are specific pharmacological responses on some of the dimensions (eg, mania/excitement responding to mood stabilizers)[7,9] and also specific responses to psychosocial interventions (eg, positive symptoms responding to

cognitive behavioral therapy,[48] negative symptoms to art therapies,[48] cognitive disorganization to cognitive remediation[49]). In the absence of computer-based assessment methods, which have been applied in depression[50] and other medical conditions[51] to derive reliable and valid scores from item response models for use in clinical practice, clinicians may use sum scores of PANSS items that were strongly related to general and specific psychosis dimensions as crude proxies of these (see table 5).

With the publication of DSM-V forthcoming soon, there is an urgent need to examine the validity of the general and specific psychosis dimensions further. Comparisons across diagnostic chapters of DSM-V as well as prospective studies are required to determine the longitudinal invariance, discriminant, and predictive validity of, as well as cutoff points for, these dimensions. This needs to be complemented by evidence on biological, psychological, and environmental factors that differentially predict general and specific dimensions to strengthen their role as taxonomic entities of psychosis. These improvements in the conceptualization and measurement of the diagnostic construct of psychosis may pave the way to more valid and clinically useful versions of ICD and DSM.

Supplementary Material

Supplementary material is available at http://schizophreniabulletin.oxfordjournals.org.

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