Symptoms of Schizophrenia

Methods, Meanings, and Mechanisms

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Background: The "group of schizophrenias," normally referred to with a single nominative, is phenomenologically heterogeneous. Its symptoms represent multiple psychological domains, including perception, inferential thinking, language, attention, social interaction, emotion expression, and volition. Studies of psychopathology have simplified this complex array in several ways, one of which is a subdivision into positive and negative symptoms.

Methods: This study examined the positive vs negative distinction in a sample of 243 patients with schizophrenia or schizophreniform disorder who were evaluated with the Scale for the Assessment of Negative Symptoms and the Scale for the Assessment of Positive Symptoms. A two-stage factor analysis was applied, beginning with a principal components analysis applying varimax rotation, followed by an extension analysis. The purpose of these analyses was to evaluate the correlational relationships of the various symptoms of schizophrenia.

Results: The results confirmed previous reports by our group and others suggesting that the symptoms of schizophrenia fall into three natural dimensions, as assessed by the correlational interrelationships: positive symptoms subdivide into psychotic and disorganized dimensions, while a third negative dimension also emerges.

Conclusion: Because these dimensions have impressive consistency across studies, future work must examine their relationship to clinically relevant concepts such as prognosis or etiology and examine four different aspects: longitudinal course, neural mechanisms, relationship to treatment, and interrelationships in other pathological conditions.

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THE GROUP of illnesses that we conventionally refer to as "schizophrenia," typically using a single nominative for simple verbal convenience (and perhaps out of intellectual laziness), is diverse in nature and covers a broad range of cognitive, emotional, and behavioral domains.[1-3] The symptoms used to define schizophrenia in standard nomenclatures, such as *DSM-IV*[4] or *International Classification of Diseases, 10th Revision*,[5] include various forms of delusions, hallucinations, thought disorders, and abnormalities in emotional expression, social interaction, attention, and volition and drive. From the perspective of cognitive psychology, these symptoms represent a variety of systems, including inferential and abstract thinking; language; appetitive drives; auditory, visual, and tactile perception; and a host of others. This situation presents us with several paradoxes that make it difficult for both novices and experienced professionals to "get their minds around" the concept of schizophrenia. First, we typically use a single word to refer to a disorder that may be etiologically and pathophysiologically heterogeneous and therefore constitutes multiple illnesses that should properly be referred to as "the schizophrenias." Second, this disorder is also cross-sectionally and symptomatically heterogeneous; that is, two patients given this diagnosis may have totally different and nonoverlapping symptom patterns, if the current *DSM-IV* diagnostic criteria are applied. Stated succinctly, these paradoxes reduce to: the *schizophrenias* are a polythetic construct.

Investigators have used a variety of mental mechanisms and intellectual strategies to cope with the confusion and chaos

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METHODS

SUBJECTS

Subjects in this study consisted of 243 patients with either schizophrenia or schizophreniform disorder who were consecutively admitted to the Mental Health Clinical Research Center (MHCRC) at The University of Iowa Hospitals and Clinics in Iowa City. All patients admitted to the MHCRC receive a comprehensive evaluation that includes the CASH as well as weekly ratings using the SANS and SAPS. All the patients were diagnosed using *DSM-III-R* diagnostic criteria. Diagnoses were established using two consensus conferences, one occurring shortly after admission and the second occurring at the time of discharge. Senior MHCRC medical staff participated in these consensus diagnostic sessions, which involved integration of cross-sectional interview data with repeated longitudinal assessments and information obtained from family members and previous treating physicians. The subjects in this study consisted of 229 patients having a diagnosis of core schizophrenia and 14, schizophreniform disorder. Patients also received a comprehensive general medical evaluation (history and physical examination) and were excluded if they suffered from a general medical or neurological disorder. The clinical and demographic characteristics of these patients are summarized in **Table 2**. Seventy-four patients were female and 169 were male.

RATINGS

The ratings of positive and negative symptoms used for analysis in this particular study were taken from the SANS and SAPS scales in the "Current Condition" section of the CASH. These particular ratings were selected for analysis because they were considered to provide the purest and most accurate measure of core or trait symptoms in this group of patients. As administered in the MHCRC, the CASH involves repeated evaluations and assessments throughout the hospital stay, including a 3-week medication washout period for most patients. Ratings of positive and negative symptoms for the current condition assess each sign or symptom at its worst during the past month; for those patients (particularly first-episode patients) who have been ill for longer than a month, but with clearly defined onset, the symptom is rated at its worst during the entire episode. These rating instructions are designed to permit investigators to capture the manifestation of each symptom in a way that will reflect the underlying pathophysiology to the greatest extent possible. Because nearly all the patients were evaluated in a medication-free state, we were able to observe positive symptoms emerge that might otherwise have been covered over through treatment effects. Further, we also were able to evaluate negative symptoms independent of drug side effects. The reliability of the various SANS and SAPS items has been assessed repeatedly and has been found to be good to excellent for most items, using both interrater and test-retest reliability measures.[2,30,58]

RATERS

The SANS and SAPS ratings used in these analyses were completed at the consensus conference conducted at the time of discharge by the research team; they are based on an agreement between the research psychiatrist who has cared for the patient throughout the hospital stay, nursing personnel who have observed the patient on a daily basis, and a research assistant assigned to follow each patient. Thus, they represent longitudinal rather than cross-sectional ratings. All the raters participated in weekly training and calibration meetings to ensure that ratings remained stable over time and that rater drift did not occur.

DATA ANALYSIS

Data analysis was conducted in two stages. An initial principal components analysis was used to validate the previous three-dimensional results and to provide structural definition for an extension analysis. Based on our earlier work,[97,98] we selected delusions, hallucinations, bizarre/disorganized behavior, positive formal thought disorder, inappropriate affect, affective flattening, anhedonia/asociality, and avolition/apathy as the symptoms for the initial analysis. Alogia and attentional impairment were withheld for the extension analysis because the specific purpose of this part of the study was to determine the interrelationships between items on these subscales to guide decisions concerning future revisions. Our previous analyses suggested that these two symptoms might be factorially complex. In the principal components analysis, the criterion used to select the number of factors was eigenvalues greater than unity. A maximum likelihood factor solution verified the number of factors. The initial factor solution then was rotated to simple structure using the varimax procedure.

To study the dimensional nature of the individual items in the SANS and SAPS as well as the global items excluded from the preliminary principal components analysis, an extension analysis of the principal components factor structure was explored.[107] This statistical procedure requires calculating factor scores from the principal components analysis and correlating them with the item scores. Correlations also were computed for the alogia and attentional impairment items that were not included in the principal components analysis. Statistical tests of these correlations are appropriate because the items that were not included in the factor solution are free to vary. However, because there are 50 items correlated across three factors, finding significant correlations capitalizes on chance. Therefore, a Bonferroni correction was applied to the statistical tests. A significance level of .001 was used to test the correlations.

Finally, multiple R^2 values were calculated between the individual items of a given symptom and its global rating. The purpose here was to provide a measure of internal consistency between a global rating and individual items of a symptom. A large R^2 suggests that the item ratings, taken together, differentiate subjects in a manner similar to the global rating. This lends support to the validity of the global rating. The global rating should reflect symptom severity as a function of the observable behavioral characteristics sampled by the item ratings.

produced by that observation. One strategy has been to identify core symptoms that are either highly specific or pathognomonic. Examples include the Bleulerian four A's, or more properly six A's (associations, affective, ambivalence, autism, attention, and avolition).[6] Kraepelin concurred with Bleuler in that if any symptoms could be considered fundamental or core, they would be "a weakening of those emotional activities which promptly form the mainspring of volition and the loss of the inner unity of activities, intellect, emotion, and volition."[7] Schneiderian first-rank symptoms represented an alternative approach to identifying pathognomonic symptoms.[8-10] The Bleulerian-Kraepelinian emphasis ran aground because of concerns about both specificity and reliability, while the Schneiderian influence has been reduced because of nonspecificity.[11-24] In the turbulent conceptual waters that were produced in the absence of a single clear guideline as to the essence of the group of schizophrenias, the concept of positive and negative symptoms emerged for a time as a calming influence.[25-52] This approach to discussing the symptoms of schizophrenia has dominated the past decade.

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The earliest comprehensive discussion of positive and negative symptoms was presented by Hughlings-Jackson, a 19th-century neurologist, although Reynolds had made an earlier, less extensive presentation.[25-27] Jackson was writing in a era when evolutionary theory provided the prevailing worldview, and he developed a model of brain function that reflected it: the brain was organized like an onion, with deeper primitive layers to which higher, more civilizing layers were added. Jackson applied this model to the understanding of various syndromes, including the psychoses. He suggested that positive symptoms, such as delusions or hallucinations, represented release phenomena; they were symptoms arising when a higher cortical regulator or organizer had been lost and the activity from a lower level therefore emerged unchecked. Negative symptoms, such as avolition or emotional blunting, were due to "dissolution"; that is, they represented a diffuse or generalized loss of higher centers.

While Fish[53] and others[54] in Britain had echoed Jacksonian concepts, Strauss et al[28] were the first to write a comprehensive discussion of Jacksonian ideas in relation to the group of schizophrenias in recent times. They proposed that three kinds of manifestations of schizophrenia could be used to evaluate prognosis and outcome: positive symptoms, negative symptoms, and disordered relationships. They suggested that positive symptoms were relatively nonspecific and prone to fluctuate, while negative symptoms and disorders of personal relationships were more fundamental and likely to have greater prognostic significance. They also proposed that this conceptualization be largely descriptive, rather than rooted in a Jacksonian model of brain function. Although forward-looking, this set of ideas did not capture the collective imagination of psychiatric investigators to the same extent as Crow's[29] formulation of the two-syndrome hypothesis in 1980. Crow's two-syndrome model of schizophrenia has been widely discussed and studied, largely because it combined within a single theoretical model methods for thinking about onset, cross-sectional symptoms, outcome, treatment, and underlying neural mechanisms.[43-52] Crow proposed that a positive type of schizophrenia was characterized by acute onset, prominent positive symptoms, normal brain structure and function, a biochemical disorder involving dopaminergic transmission, good response to neuroleptics, and better outcome, while the negative type was characterized by an opposite pattern and most important by underlying structural abnormalities that were irreversible and led to poor neuroleptic response. While the Strauss formulation was purely descriptive, the Crow formulation returned the positive/negative distinction to a Jacksonian tradition in form, if not content, by rooting thinking about positive and negative symptoms in brain-behavior relationships.

One elemental component in discussions of positive and negative symptoms during the past decade has involved discussions about the best methods for defining and rating these symptoms. Two scales, the Scale for the Assessment of Negative Symptoms (SANS) and the Scale for the Assessment of Positive Symptoms (SAPS) were developed in 1982 to permit exploration of the clinical and neural correlates of these symptoms in schizophrenia and related psychotic illnesses, with the recognition that they would be relevant to the study of various affective disorders as well.[30-42]

These scales draw on constructs of cognitive psychology and identify domains that are relevant to the study of schizophrenia: perception, inference, language, behavioral monitoring, behavioral activity, emotional expression, conceptual and verbal fluency, pleasure drives, volition, and attention.[55-57] Early versions of the SANS and SAPS identified 10 symptoms that corresponded to these domains, five of which were positive and five of which were negative: hallucinations, delusions, positive thought disorder, bizarre/disorganized behavior, catatonic motor behavior, affective blunting, alogia, anhedonia, avolition, and attentional impairment.[30-33] Following Jacksonian thinking, the first five of these symptoms were considered to be positive because they represented distortions in normal functions that could be due to injury at a higher cortical level, while the five negative symptoms simply represented a loss of a function.[55] A principal components analysis of the first sample to be studied with these scales revealed a first factor that accounted for 42% of the variance and that had large positive loadings on affective flattening, alogia, avolition, anhedonia, attentional impairment, and catatonic motor behavior, with negative loadings on delusions and hallucinations.[31] A second factor had large positive loadings on positive thought disorder and bizarre behavior. Because catatonic motor behavior was in fact extremely rare, it was subsequently dropped from the positive symptom list in early versions of the SAPS, although methods for rating it remain in the more extensive structured interview that contains the SANS and SAPS scales, the Comprehensive Assessment of Symptoms and History (CASH).[58]

Since that early study, many subsequent investigations have explored the concept of positive and negative symptoms, and the terms have achieved widespread use at the clinical level, suggesting that they may meet an im-

portant conceptual need by simplifying or clarifying thinking about the nature of the symptoms of schizophrenia.[34-52,59-96] Discussions of the distinction between positive and negative symptoms have also produced many questions and problems, however. Two of the most basic questions have echoed conceptual history as it has moved from Jackson to Strauss to Crow. Why should a symptom be classified as negative or positive? Should it be based on some hypothesized brain-behavior relationship, as it was for Jackson and Crow? Is it sufficient to show a relationship at a descriptive level, using correlational and factor analytic techniques and demonstrating predictive validity using measures such as onset, outcome, or response to treatment? Can these symptoms be assessed cross-sectionally, or must longitudinal or repeated measures be added as well? If one postulates related groups of symptoms, how are they related to one another, ie, must they be independent, or do they have some type of interactive influence on one another? What effects do other confounding factors have on the assessment of positive and negative symptoms, such as neuroleptic medication or coexisting depressive symptoms? Are any of these symptoms specific to schizophrenia, or do they occur in other disorders?

One large body of literature has adopted the descriptive strategy and applied correlational and factor analytic techniques to examine the interrelationships between positive and negative symptoms. A total of four have been completed to date within our own center,[31,36,97,98] while we know of 10 others that have been completed in other centers.[46,96,99-106] A review of these studies suggests a surprising convergence of results and indicates that, at a descriptive level, three dimensions rather than two are required to account for the interrelationships among the symptoms of schizophrenia. The positive symptoms subdivide into two dimensions, one of which is typically composed of delusions and hallucinations and represents a psychosis dimension, while the other is typically composed of disorganized speech, disorganized behavior, and inappropriate affect and represents a "disorganization dimension." The negative symptoms remain robust as originally conceptualized, apart from attention, which sometimes loads with other negative symptoms but occasionally shows a relationship to the two positive symptom dimensions. As noted in a recent review by Minas et al,[104] even our original 1982 study[31] supports the existence of three dimensions, since a varimax rotation produces a three-factor solution. The various factor analytic studies are summarized in **Table 1**. Given that they represent samples collected from all over the world (England, India, Italy, Australia, Spain, and the United States), that many are based on small samples, and that they have used a variety of different factor analytic techniques, the convergence of results is striking.

Because of the convergence, and because the SANS and SAPS are widely used throughout the world in research investigations to explore the effects of treatment and neurobiological correlates of schizophrenia, we have conducted a fifth analysis of the SANS and SAPS in their current incarnation to guide us toward revisions that can be used in the future to explore these three dimensions. We report herein on a factor analysis of a sample of 243 patients. To answer some specific psychometric questions raised by our earlier work, we have conducted the factor analysis in two stages, using an initial principal components analysis to provide a firm structural definition of the dimensions, followed by an extension analysis to examine two of the negative symptom scales (alogia and attention) in more detail. This analysis was delayed until we were able to amass a sample of adequate size. Samples of 10 to 20 subjects per variable in a multivariate analysis are normally recommended, suggesting that 100 to 200 subjects would be desirable for a study analyzing 10 symptoms. A minimum sample of 200 has been recommended for stable estimates in factor analysis.[107]

RESULTS

Means and SDs of global ratings on the SANS and SAPS are shown below.

Symptom	Mean (SD)
Avolition	3.59 (1.16)
Anhedonia	3.89 (0.92)
Affective flattening	2.78 (1.23)
Inappropriate affect	1.67 (1.62)
Positive formal thought disorder	2.13 (1.45)
Bizarre behavior	2.43 (1.34)
Delusions	3.50 (1.25)
Hallucinations	2.81 (1.73)

Pearson correlations among the SANS and SAPS items are shown in **Table 3**.

The principal components analysis of the eight items yielded a three-factor solution. The three factors accounted for 66.59% of the total variance. The maximum likelihood analysis agreed with the prinicipal components estimate of the number of factors. The test for two common factors produced a significant lack of fit (maximum likelihood χ^2=27.296, df=13, $P<.012$), while the three-factor solution fit the data well (χ^2=2.292, df=7, $P<.927$). Furthermore, the third factor provided a significant contribution (χ^2=25.004, df=6, $P<.005$) to the solution.

Table 4 shows the principal components factor structure after the factors were rotated to simple structure using the varimax rotation procedure. The first factor reflects a negative symptom dimension and accounts for 27.94% of the variance. Avolition, anhedonia, and affective flattening all load highly with this factor. All three of these negative symptoms have a correlation greater than 0.80 with the first factor. The second factor, accounting for 20.65% of the variance, reflects a disorganization dimension. Inappropriate affect and positive formal thought disorder have strong loadings with this factor. Bizarre behavior loads on the disorganization factor, although it also loads on the negative factor. The third factor reflects a dimension indicative of psychosis that accounts for 18.00% of the variance. Delusions and hallucinations load highly with this third factor.

Table 1. Studies of Schizophrenia Using Factor Analysis Techniques*

Source, y	N	Technique	No. of Factors	Comment
Andreasen et al,[31] 1982	52	PCA	2 or 3	Original PCA (unrotated) showed one large bipolar factor (positive and negative factors); later analysis using varimax shows three, corresponding to psychotic, disorganized, and negative factors
Bilder et al,[99] 1985	32	PCA, varimax rotation	3	Factor 1 combines alogia, attention, thought disorder, and bizarre behavior; factor 2, negative symptoms; factor 3, psychotic symptoms
Andreasen et al,[36] 1986	117	PCA	3, possibly 4	First two factors represented negative symptoms; factor 3, delusions and hallucinations; factor 4, bizarre behavior
Kulhara et al,[100] 1986	98	PCA	3	Negative symptoms, psychoticism, and disorganization
Moscarelli et al,[96] 1987	59	PCA	2 or 3	Clear negative factor; positive factors less cohesive
Liddle,[86] 1987	40	PCA, rotation	3	"Psychomotor poverty, disorganization, and reality distortion"; based on only a subset of SANS and SAPS items
Lenzenweger et al,[101] 1989	302	Confirmatory factor analysis using maximum likelihood techniques to compare several models	2, possibly more	Retrospective reanalysis of twin data; positive and negative factors
Schuldberg et al,[102] 1990	370	PCA, varimax rotation	2	Clear negative factor, positive factor mainly psychoticism
Arndt et al,[97] 1991	207	PCA, varimax rotation, maximum likelihood techniques	3	Negative symptoms, psychoticism, and disorganization
Gur et al,[103] 1991	47	PCA, rotation	3	Negative symptoms, psychoticism, and disorganization
Minas et al,[104] 1992	114	Multidimensional scaling	3	Negative symptoms, psychoticism, and thought disorder; based on item analysis rather than global ratings
Peralta et al,[106] 1992	115	PCA, varimax rotation	4	Negative symptoms, psychoticism, and thought disorder; loadings on bizarre behavior not reported
Brown and White,[105] 1992	139	PCA, varimax rotation	3	Cross-sectional ratings using SANS and Manchester Scale; negative symptoms, psychoticism, inattentiveness, and inappropriate affect
Miller et al,[98] 1993	90	PCA, varimax rotation	3	Negative symptoms, psychoticism, and disorganization

**PCA indicates principal components analysis; SANS, Scale for the Assessment of Negative Symptoms; and SAPS, Scale for the Assessment of Positive Symptoms.*

EXTENSION ANALYSIS OF ALOGIA AND ATTENTION

The analysis of alogia and attentional impairment is reported in **Table 5**. The alogia and attentional impairment items, as well as the global ratings, do not consistently correlate significantly with a single factor. The item correlations for alogia load with either the negative factor or the disorganization factor. The global rating for alogia correlates most highly with negative symptoms. Similarly, the items and global rating for attentional impairment correlate most strongly with the negative factor, but also show correlations with the disorganization factor.

EXTENSION ANALYSIS OF THE SANS AND SAPS ITEMS

Table 6 reports the results of the extension analysis performed on the individual items that constitute the various global ratings. The factor loadings for the global ratings are shown again for comparison. The items constituting avolition, anhedonia, and affective flattening all correlated significantly with the negative factor. Uniformly, the highest correlations for these items with the three factors occurred on the negative factor. None of the items correlated with the psychotic factor, although three of the items (grooming and hygiene, ability to feel intimacy and closeness, and decreased spontaneous move-

Table 2. Demographic and Clinical Characteristics of Subjects

Characteristic	Mean	SD
Age, y	31.98	10.57
Education, y	12.59	2.25
Age at onset, y	20.97	5.75
Global Assessment Scale score at admission	32.07	8.38
Total duration of previous hospitalizations, mo	23.14	40.42
No. of previous hospitalizations	5.70	4.97

Table 3. Pearson Correlations Among SANS and SAPS Global Ratings*

Symptom	Avolition	Anhedonia	Affective Flattening	Inappropriate Affect	Thought Disorder	Bizarre Behavior	Delusions
Avolition	1.000						
Anhedonia	0.646	1.000					
Affective flattening	0.517	0.486	1.000				
Inappropriate affect	0.122	0.140	0.010	1.000			
Thought disorder	0.112	0.146	−0.023	0.336	1.000		
Bizarre behavior	0.412	0.400	0.247	0.315	0.378	1.000	
Delusions	0.239	0.201	0.078	0.058	0.292	0.311	1.000
Hallucinations	0.230	0.197	0.184	0.113	0.132	0.214	0.347

*SANS indicates Scale for the Assessment of Negative Symptoms; SAPS, Scale for the Assessment of Positive Symptoms.

ment) had modest but significant correlations with the disorganization factor.

The items constituting positive formal thought disorder all correlated significantly with the disorganization factor. Except for the derailment item's significant correlation with the psychotic factor, none of the items correlated with either the negative or the psychotic factor.

The items constituting bizarre behavior, however, did not show as distinctive factor loadings as positive formal thought disorder on the disorganization factor. Although three of the four items had their highest correlations with the disorganization factor, many of the items also correlated significantly with the negative factor. This mirrors the split loading of the global rating of bizarre behavior with the negative factor and disorganization factor in the principal components analysis.

The items constituting delusions and hallucinations clearly correlated with the psychotic factor. All these correlations were the highest for the psychotic factor. Only grandiose delusions correlated significantly with another factor. Because of a low base rate (mean item rating=0.21, SD=0.71), the delusions of jealousy item failed to correlate significantly with any factor.

The multiple R^2 values for all global ratings with their respective scale items were all greater than 0.70 and most were greater than 0.80. Thus, the individual items demonstrate good internal consistency.

COMMENT

A fifth factor analysis study from our group has again shown that positive and negative symptoms do not subdivide neatly into two categories. These results are quite similar to four previous studies completed at Iowa. The first study,[31] reported in 1982, was interpreted at the time as suggesting the possibility of only two dimensions, but this finding is primarily the result of not subjecting the data to varimax rotation; after rotation, the factor structure appears similar to that observed in the study herein.[104] Our second study,[36] reported in 1986, suggested the possibility of four factors, with the first and second representing two different aspects of negative symptoms; the third, psychoticism; and the fourth, thought disorder. Our third study,[97] reported in 1991, again suggested that the symptoms might be best described by the dimensions of psychoticism, disorganization, and negative symptoms. A fourth study,[98] reported in 1993, had similar results. Most of these studies also have reported correlation matrices, and most have commented on the fact that indices of internal consistency within the positive symptom scale, usually as measured by Cronbach's α, have been low, suggesting that positive symptoms are not a homogeneous concept. Thus, recent reports from other centers suggesting the nonhomogeneity of positive symptoms are not a surprise and are consistent with observations that we have made since the original description of rating scales for positive and negative symptoms in 1982. Cronbach's α for positive symptoms as reported in 1982 was .397 compared with .849 for negative symptoms.[31] Taken as a group, these studies conducted over the past decade comprise more than 500 patients and represent the largest repeated and systematic study of the correlational relationships between the symptoms of schizophrenia that has been completed to date.

At the descriptive level, the conclusions seem clear. Like schizophrenia itself, the symptoms are heterogeneous when assessed using the correlational methods of factor analysis. Such a consistency of results within a single group and from other groups throughout the world is quite reassuring, given the difficulties in replicating findings that often occur in the study of schizophrenia.

Nevertheless, we should also remind ourselves what factor analysis can and cannot tell us. Factor analysis is essentially a data reduction method. It demonstrates which items in a group are highly correlated with one another, indicating that they co-occur together. Demonstrating that they co-occur does not necessarily prove a conceptual relationship or an etiological relationship, however. The relationship is simply descriptive until other methods are used to demonstrate that the relationship has conceptual, diagnostic, clinical, or biological meaning. Extensive additional study is needed before inferences can be made concerning these aspects of the interrelationships between the symptoms of schizophrenia. One cannot infer that these symptoms are likely to have a common mechanism or etiology, nor can one infer that they have important prognostic significance. This must be demonstrated through empirical research. The robustness of the findings across various groups does suggest good generalizability, but at this point the generalizability is limited to core schizophrenia, since most studies have been limited to samples composed of patients given that *DSM* diagnosis. The applicability of these relationships to other patients within the schizophrenia spectrum or to other diagnostic groups (eg, psychotic mania or depression) is still an open question.

Table 4. Varimax Rotated Factor Structure for SANS and SAPS Global Ratings*

Symptom	Factor		
	Negative	Disorganized	Psychotic
Avolition	**0.832**	0.131	0.172
Anhedonia	**0.818**	0.179	0.110
Affective flattening	**0.809**	−0.105	0.036
Inappropriate affect	0.057	**0.796**	−0.114
Thought disorder	−0.050	**0.754**	0.267
Bizarre behavior	**0.426**	**0.598**	0.249
Delusions	0.071	0.175	**0.821**
Hallucinations	0.168	0.012	**0.759**
Variance explained	2.235	1.652	1.440
Percentage	27.938	20.650	18.000

**SANS indicates Scale for the Assessment of Negative Symptoms; SAPS, Scale for the Assessment of Positive Symptoms. The highest correlations (r>0.4) on a factor for a given item is boldfaced.*

Table 5. Correlation of Factor Scores With Alogia and Attention*

Symptom	Factor		
	Negative	Disorganized	Psychotic
Alogia			
Poverty of speech	**0.589**†	−0.010	−0.123
Poverty of content of speech	0.115	**0.467**†	0.075
Blocking	0.135	**0.193**	0.110
Increased latency of response	**0.458**†	0.132	0.064
Perseveration	0.022	**0.218**‡	0.009
Global rating	**0.574**†	0.216‡	−0.029
R^2=0.739			
Attention			
Social inattentiveness	**0.477**†	0.327†	0.133
Inattentive during mental testing (n=232)	0.259†	**0.295**†	0.164
Global rating	**0.454**†	0.335†	0.153
R^2=0.848			

**The highest correlation on a factor for a given item is boldfaced.*
†P<.0001.
‡P<.001.

Should the vocabulary used to discuss the symptoms of schizophrenia be changed and references to positive and negative symptoms be dropped altogether? Changes in usage will no doubt evolve naturally. A terminology that speaks of positive and negative symptoms using the words descriptively to refer to exaggerations of normal functions vs loss of normal functions seems to have found a comfortable linguistic niche in clinical usage, since it provides a modest conceptual simplification to clinicians grappling with the complex symptomatology of schizophrenia. Positive symptoms are readily understood as those that are more florid and that tend to be more associated with exacerbations of the illness, while negative symptoms tend to have a basic underlying persistence. Looked at in a more fine-grained way, positive symptoms subdivide into two dimensions: psychoticism (delusions and hallucinations) and disorganization (positive formal thought disorder, bizarre behavior, and inappropriate affect). As we move toward discussing these three dimensions of psychopathology, we must keep in mind that they are dimensions and not subtypes. That is, although a factor analysis can pull them apart statistically, these dimensions often overlap within given individuals. Unitary categorization without overlap defines a subtype, while dimensions have magnitude, may overlap, and can be additive.

These results suggest specific future directions for the use of the SANS and SAPS. Because of their wide use, they have not been subjected to extensive revisions to date, since such tinkering can be confusing and disruptive for the investigators who use them. Work on revised versions of the scales currently is under way; however, this work will emphasize designing the scales so they can be used more efficiently to explore the three dimensions, will involve a more detailed description of various aspects of attention so their components and correlates can be examined, and will involve more work on other subitems such as poverty of content of speech. As of now, we believe the current results suggest that in dimensional analyses, negative symptoms may include alogia, affective blunting, anhedonia, avolition, and attention. Attention should only be considered a negative symptom at a provisional level, however, because it has the least robust correlation and may ultimately be heterogeneous. Alogia may be better assessed if the current poverty of content item is revised and defined differently. Poverty of speech and poverty of content are linked conceptually and yet currently defined in such a way that they cannot be correlated with one another; the definitions specify that poverty of speech involves limited speech, while poverty of content involves speech that is adequate in amount but empty in content. Thus, one or the other of these possible components of alogia can be present but both cannot occur together. Because factor analysis separates uncorrelated items, it pulls apart two symptoms that are associated conceptually through sharing the fundamental characteristic of intellectual emptiness. In factor analysis studies, poverty of content tends to spill over to positive thought disorder, which also is characterized by abundant speech that is difficult to understand. Thus, definitional changes may be needed for poverty of content as its relationship to alogia is evaluated in future studies.

Future directions in the study of the symptoms of schizophrenia should emphasize efforts to link clinical description with models, meanings, and mechanisms. Techniques such as factor analysis will take us only part of the way to understanding the symptoms of this illness and its interrelationships. Empirical description alone will lead to intellectual bankruptcy. Until symptoms are linked to clinically relevant concepts such as prognosis or etiology, no firm conclusions can be reached about the best way to divide or group the symptoms of schizophrenia. The ultimate level of understanding will be based on learning how these symptoms are produced at the level of brain mechanisms. Future studies also should pursue at least four different aspects of these dimensions: their neural mechanisms, longitudinal course, relationship to treatment, and interrelationships in other pathological conditions apart from schizophrenia.

The robustness of these three dimensions suggests that they are a launching platform for exploring neural correlates. Our ability to build models will be limited necessarily by our relatively limited understanding about how cog-

Table 6. Correlation of Factor Scores With SANS and SAPS Ratings*

Symptom	Factor: Negative	Disorganized	Psychotic
Avolition/apathy			
Grooming and hygiene	**0.568†**	0.216‡	0.158
Impersistence at work or school	**0.735†**	0.173	0.177
Physical anergia	**0.643†**	−0.088	0.108
Global rating	**0.832**	0.131	0.172
R^2=0.840			
Anhedonia/asociality			
Recreational interests and acts	**0.675†**	0.176	0.151
Sexual interests and activity	**0.435†**	0.004	0.066
Ability to feel intimacy/closeness	**0.367†**	0.260†	0.120
Relationships with friends/peers	**0.667†**	0.192	0.109
Global rating	**0.818**	0.179	0.110
R^2=0.820			
Affective flattening			
Unchanging facial expression	**0.751†**	−0.153	0.049
Decreased spontaneous movement	**0.481†**	−0.225§	−0.077
Paucity of expressive gestures	**0.595†**	−0.077	−0.065
Poor eye contact	**0.526†**	0.132	0.088
Affective nonresponsivity	**0.588†**	0.004	0.174
Lack of vocal inflection	**0.563†**	−0.027	−0.035
Global rating	**0.809**	−0.105	0.036
R^2=0.894			
Inappropriate affect			
Global rating	0.057	**0.796**	−0.114
Positive formal thought disorder			
Derailment	−0.007	**0.732†**	0.238§
Tangentiality	−0.017	**0.709†**	0.183
Incoherence	0.055	**0.427†**	0.003
Illogicality	−0.075	**0.415†**	0.002
Circumstantiality	−0.178	**0.340†**	0.182
Pressure of speech	−0.182	**0.355†**	0.154
Distractible speech	−0.005	**0.320†**	0.185
Clanging	−0.051	**0.304†**	−0.029
Global rating	−0.050	**0.754**	0.267
R^2=0.868			

Table 6. Correlation of Factor Scores With SANS and SAPS Ratings* (cont)

Symptom	Factor: Negative	Disorganized	Psychotic
Bizarre behavior			
Clothing and appearance	0.132	**0.268†**	0.104
Social and sexual behavior	0.329†	**0.539†**	0.160
Aggressive and agitated behavior	0.232§	**0.479†**	0.288†
Ritualistic or stereotyped behavior	**0.252†**	0.130	−0.035
Global rating	0.426	**0.598**	0.249
R^2=0.770			
Delusions			
Persecutory delusions	0.072	0.164	**0.635†**
Delusions of jealousy	−0.039	0.028	**0.120**
Delusions of sin or guilt	0.160	−0.034	**0.258†**
Grandiose delusions	−0.001	0.265†	**0.327†**
Religious delusions	0.064	0.163	**0.329†**
Somatic delusions	−0.026	0.034	**0.296†**
Ideas and delusions of reference	0.092	0.082	**0.479†**
Delusions of being controlled	0.060	−0.025	**0.334†**
Delusions of mind reading	0.030	−0.021	**0.418†**
Thought broadcasting	0.045	−0.048	**0.262†**
Thought insertion	0.005	−0.042	**0.334†**
Thought withdrawal	0.025	−0.028	**0.257†**
Global rating	0.071	0.175	**0.821**
R^2=0.704			
Hallucinations			
Auditory hallucinations	0.151	0.016	**0.684†**
Somatic/tactile hallucinations	0.004	0.083	**0.392†**
Olfactory hallucinations	0.027	−0.014	**0.216‡**
Visual hallucinations	0.174	0.083	**0.404†**
Global rating	0.168	0.012	**0.759**
R^2=0.874			

**SANS indicates Scale for the Assessment of Negative Symptoms; SAPS, Scale for the Assessment of Positive Symptoms. The highest correlation on a factor for a given item is boldfaced.*

†P<.0001.

‡P<.001.

§P<.0005.

nitive functions such as attention or language are mediated in the normal brain. A consensus has clearly emerged that simple localization models (ie, localization of language in the left hemisphere perisylvian area) are not sufficient, that language may be bilaterally represented, and that it is based on distributed parallel processing. The distributed processing models of brain function currently proposed in cognitive neuroscience almost certainly reflect a more real view of how the brain works, but they also complicate building models that will link the understanding of psychopathology to neural mechanisms. Nevertheless, we will be unable to understand what these various symptoms mean until we can define them at the neural level. Thus, future explorations of these dimensions will use the techniques of experimental cognitive psychology, neuropsychology, and neuroimaging to examine interrelationships between them and their underlying neural mechanisms.

A second way in which these three dimensions should be explored is an examination of their longitudinal course. Past and current wisdom suggest that negative symptoms are likely to be more persistent and fundamental, while psychotic symptoms are associated more with exacerbations. The disorganization dimension is conceptually newer, less studied, and less clear. To some extent, the meaning of these dimensions may be disorder specific; disorganized speech tends to remit in mania, while it tends to persist in schizophrenia.[108] Investigation of the longitudinal course of symptoms has important implications for understanding neural mechanisms, since symptoms that wax and wane are probably produced by mechanisms different from those of symptoms that remain more persistent. Identification of different patterns of course across disorders also may lead to identifying different mechanisms for a given symptom within a

Table 7. Dimensional-Diagnostic Crosswalk

Factor	Core Schizophrenia	Schizophreniform Disorder	Schizotypal Personality Disorder	Simple Schizophrenia	Schizoaffective Disorder	Mania	Depression
Psychotic	X	X			X	X	X
Disorganized	X	X			X	X	
Negative	X	?	X	X	?		X

Table 8. The Symptom Spectrum

Symptom	Core Schizophrenia	Schizophreniform Disorder	Schizotypal Personality Disorder	Simple Schizophrenia	Schizoaffective Disorder	Mania	Depression
Delusions	X	X			X	X	X
Hallucinations	X	X			X	X	X
Disorganized speech	X	X			X	X	
Disorganized behavior	X	X		?	X	X	
Inappropriate affect	X	X			X		
Attention	X	X			X	X	X
Alogia	X	?	X	X	X		X
Affective blunting	X	?	X	X			X
Anhedonia	X	?	X	X			X
Avolition	X	?	X	X			X

given disorder. For example, although hallucinations occur in schizophrenia, delirium, mania, and lysergic acid diethylamide–induced psychosis, the time pattern is different in all four disorders. The first stage in examining the course of symptoms must, however, establish a solid empirical base. The companion article in this issue of the ARCHIVES[109] on the longitudinal course of these three dimensions provides an example of one preliminary effort at empirical description of the course of symptoms and dimensions.

Examination of these three dimensions in other pathological conditions is another important avenue for exploration. Both the three dimensions and the individual symptoms discussed in this report also occur in other disorders. **Table 7** and **Table 8** provide an illustrative crosswalk. To the extent that there is a commonality of symptoms or dimensions across disorders and that evidence from other validators suggests a commonality of mechanism, we may be able to obtain additional leverage on building models to explain dimensions or symptoms. For example, "hypofrontality" has been repeatedly reported in schizophrenia and, using techniques from neuroimaging, has sometimes been found to be associated with negative symptoms.[110-112] Hypofrontality also has been observed relatively consistently in depression, using both neuroimaging techniques and lesion methods.[113-115] Obvious conceptual links exist between negative symptoms and depressive symptoms. Although students of psychopathology in the past have often emphasized specificity and attempted to identify pathognomonic symptoms, it may be that identifying commonalities among symptoms across disorders is a more helpful strategy for identifying underlying neural mechanisms. Again, the first step must be descriptive. Only a modest literature currently exists that applies standardized rating techniques to the study of mania, depression, the dementias, and other disorders that share many of the symptoms of schizophrenia.[37,116,117]

A final strategy must involve the study of these dimensions in relation to treatment. Again, clinical lore indicates that some symptoms and dimensions are more amenable to treatment than others. Psychotic symptoms in affective disorders tend to respond well to neuroleptics and also respond well, although less robustly, in schizophrenia. Observations such as these are powerful for generating hypotheses about the underlying mechanisms of symptoms and dimensions. As the therapeutic armamentarium grows to include medications that affect various components of individual transmitter systems (eg, the various classes of dopamine receptors), as well as other transmitter systems (eg, serotonin, norepinephrine, glutamate, γ-aminobutyric acid), our understanding of the neural mechanisms of these symptoms will grow. Much work also needs to be done at the simple descriptive level. For example, nearly all factor analysis studies completed to date have evaluated treated patients with variable levels of chronicity. It should be interesting to determine whether the same dimensions are found in first-episode patients or in untreated patients.

As these explorations progress, we should be prepared to entertain the possibility that each of the various individual symptoms may have somewhat different mechanisms and that our correlational observations suggesting three dimensions may begin to fall apart. For example, delusions and hallucinations are correlated consistently in almost all studies completed to date. At the neural level, however, they very likely are produced by different mechanisms. Thus, future explorations of the mechanisms and meanings of the three dimensions of psychopathology consistently noted in studies to date should not assume that the matter is prematurely closed and that three dimensions are sufficient. Alternately, it is also possible that these apparently separate and uncorrelated dimensions could be due to a single mechanism.

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