Schizophrenia Bulletin vol. 32 no. 2 pp. 238–245, 2006
doi:10.1093/schbul/sbj013
Advance Access publication on October 27, 2005

The Structure of Negative Symptoms Within Schizophrenia: Implications for Assessment

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This review examines the structural validity of negative symptoms focusing on 2 questions: (1) Do negative symptoms represent a domain separate from other symptoms in schizophrenia? and (2) Within negative symptoms, is there a structure that suggests multidimensionality? Results from exploratory and confirmatory factor analytic studies are examined to address these questions. Across studies and symptom instruments, negative symptoms appear to consistently emerge as a factor separate from other dimensions of the illness in schizophrenia. Whether 2-, 3-, or 5-factor models are identified, negative symptoms consistently load on a factor separate from positive symptoms, affective symptoms of depression or anxiety, and symptoms of disorganization. Focusing on negative symptoms themselves, factor analytic findings suggest that this construct is multidimensional with at least 2 factors (involving diminished expression and anhedonia-asociality). Although these factors were replicable, serious limitations were noted in this literature. Thus, 2- (or even 3- or 5-) factor models of negative symptoms should not be considered definitive, but rather all converge to support the general conclusion of the multidimensionality of negative symptoms. The later findings indicate the importance of employing assessments that provide adequate coverage of the broad domain of negative symptoms. Importantly, caution is noted in the interpretability of findings based on existing instruments, and implications for future assessment are discussed.

Key words: negative symptoms/factor analysis/ SANS/PANSS

Although there is compelling evidence regarding the clinical and theoretical importance of negative symptoms, a critical issue concerns how best to measure this domain of phenomenology within schizophrenia. A variety of instruments have become available to rate negative symptoms in schizophrenia. These instruments include the Scale for the Assessment of Negative Symptoms (SANS),[1, 2] the Positive and Negative Syndrome Scale (PANSS),[3] and, for the assessment of primary and enduring negative symptoms, the Schedule for the Deficit Syndrome (SDS).[4] Given the last 15–20 years of research on these instruments, it is an appropriate time to evaluate our understanding of the measurement of negative symptoms. In particular, the current review will focus on the structural validity of negative symptoms.[5] Structural validity can be examined using factor analysis in order to address important theoretical questions regarding the intercorrelations of schizophrenic symptomatology. Specifically, 2 structural questions arise: (1) Do negative symptoms represent a domain separate from other symptoms in schizophrenia? and (2) Within negative symptoms, is there a structure that suggests multidimensionality (ie, are there different components of negative symptoms that may require separate assessment so as to provide adequate measurement of the broader construct)? The following review will address these questions in turn.

The Overall Structure of Schizophrenic Symptomatology

A large number of studies have now examined the validity of the distinction between positive and negative symptoms (for a review, see Peralta and Cuesta 2001[6]). These have included both exploratory factor analytic (EFA) studies, as well as more rigorous testing of competing models utilizing confirmatory factor analysis (CFA), including a meta-analytic CFA.[7] A number of symptom measures have been studied, including the SANS, the Scale for the Assessment of Positive Symptoms (SAPS),[8] the Brief Psychiatric Rating Scale (BPRS),[9] and the PANSS,[3] among others. The following general summary will provide an examination of results across instruments that include items or scales tapping negative symptoms. Attention to a variety of instruments allows for an appreciation of how characteristics of input variables (the type and number of symptoms) have a direct impact on the number of factors that emerge from studies of schizophrenic symptomatology. Relatedly, the examination of factor structure across instruments provides an informative test of the robustness of a negative symptom

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factor (ie, is this factor replicable despite differences in the type and number of symptoms assessed in different instruments?).

Early exploratory factor analyses of symptom assessments tapping positive and negative symptoms (eg, relying on the combined SANS and SAPS) initially suggested a 2-dimensional model composed of independent and largely uncorrelated positive and negative symptom factors.[10–22] However, subsequent studies have found the 2-factor model inadequate. Three-factor models,[10–12, 18,23–27] have consisted of positive and negative symptom factors with a third factor that, while differing in precise item content across studies, is often described as a disorganization factor (typically involving thought disturbance and bizarre behavior but at times including poverty of content of speech and attentional impairment[eg,12,18]). In a meta-analysis of the SANS and positive symptom ratings, Grube, Bilder, and Goldman[28] found that data across 10 empirical studies fit the 3-factor model involving positive, negative, and conceptual disorganization factors. Other 3-factor models have found the third factor to involve disordered social adjustment.[29]

Results from these studies provide compelling support for the distinctiveness of negative symptoms, but they have also indicated that some symptoms originally considered to be related to negative symptoms may fit poorly with the negative symptom factor. Potentially problematic symptoms include inappropriate affect, poverty of content of speech, and attentional impairment.[10,23] Moreover, scale-level analyses have found alogia and attention to load on the negative, as well as on the disorganization factor.[eg,28] Item-level analyses focusing on negative symptoms may clarify these issues and will be addressed below.

Although the nature of the 3-factor solutions may differ across studies, negative symptoms consistently emerge as one of the factors, separate from positive symptoms and symptoms of disorganization or thought disorder. However, despite the replicability of the 3-factor model, some data have suggested a more complex factorial structure. Peralta and Cuesta[30] conducted an item-level EFA of the SANS and SAPS within a large sample of individuals with psychotic disorders, including schizophrenia. The authors identified 11 factors, 2 of which reflected negative symptoms (poverty of affect/speech and social dysfunction). Second-order factor analysis did identify higher-order factors that fit the 3-factor solution described above, but as noted by Peralta and Cuesta,[30] this 3-dimensional model may not adequately account for variance in symptoms assessed. It is interesting that even in the multifactorial model obtained by Peralta and Cuesta,[30] negative symptoms were separate from other symptoms, with blunted affect and asociality-anhedonia comprising separate (but correlated) factors.

Although these findings are informative, consideration of broader symptom assessment instruments may be useful, as the SAPS and SANS do not include evaluation of important clinical symptoms such as depression and anxiety. The BPRS is a frequently utilized clinical rating instrument that assesses a range of symptomatology. Using CFA techniques, Mueser, Curran, and McHugo[31] examined the factor structure of the BPRS in schizophrenia. After trimming 2 items (disorientation and excitement), results indicated support for a 4-factor model involving thought disturbance (positive symptoms), anergia (negative symptoms of blunted affect, emotional withdrawal, motor retardation), affect (depression and anxiety), and disorganization (conceptual disorganization). Longitudinal analyses of individuals with schizophrenia diagnoses have demonstrated that this 4-factor model is stable over time.[32] As with the 3-factor solutions for the SAPS/SANS, the 4-factor models derived from the BPRS again provide support for independent factors of positive and negative symptoms. Importantly, negative symptoms were also independent of symptoms of depression and anxiety. Similar to the 3-factor model based on the SANS and SAPS, a disorganization factor was also replicated. The limitation of BPRS-based factor analytic studies is that the BPRS fails to assess the full range of negative symptoms (eg, it lacks items relating to anhedonia or asociality). Thus, the BPRS-based factor structure may not adequately represent the structure of symptoms within schizophrenia.

The PANSS[3] was developed to tap both positive and negative symptoms, as well as general psychopathology (adapting 18 items from the BPRS). Over 17 published studies have examined the factor structure of the PANSS (see review by Emsley, Rabinowitz, and Torreman[33]) with a 5-factor solution involving negative, positive, activation, dysphoric mood, and autistic preoccupation. The 5-factor solution has been supported by both EFA and CFA in a large multisite study.[34] The 5-factor model appears to be applicable across both acute and chronic phases of schizophrenia[35] and has also emerged in both male and female schizophrenia patients.[36] Despite the apparent consistency with the 5-factor solution, the composition of the negative symptom factor within the PANSS pentagonal model has varied. Emsley, Rabinowitz, and Torreman[33] found that in the forced 5-factor solution, the negative symptom factor included blunted affect, emotional withdrawal, poor rapport, passive/apathetic social withdrawal, lack of spontaneity and flow of conversation, as well as items from the PANSS "general" scale, including active social avoidance, motor retardation, and disturbance in volition. Similar item loadings on the negative symptom factor were reported by White et al.[34] (after trimming 5 items from the PANSS), with the addition of mannerisms and secondary loadings with uncooperativeness and impulsivity. A more restricted solution was found by Nakaya, Suwa, and Ohmori,[35] using CFA with the negative symptom factor consisting of blunted affect, poor rapport, and lack of spontaneity and flow of conversation.

The pentagonal model of symptoms derived from the PANSS appears robust; however, other results raise questions about the adequacy of this model. Although Emsley, Rabinowitz, and Torreman[33] replicated a forced 5-factor solution that corresponded to earlier factor structures, these investigators also noted that an EFA yielded a 7-factor structure (with motor, depression, and anxiety symptoms emerging as separate factors). These authors concluded that the apparent uniformity in 5-factor findings is somewhat misleading.[33] Relatedly, two CFA studies of the PANSS have found that the pentagonal model had inadequate goodness of fit.[37,38]

Summary

In examining the literature on the overall structure of symptoms within schizophrenia, it appears that a good deal of support has been marshaled for 3- and 5- factor models. One evident pattern is that broader symptom assessments yield a larger number of factors. However, critical reviews of this literature have noted that these models may continue to be inadequate. In a meta-analysis of CFA studies (including the SANS, SAPS, BPRS, and PANSS), Smith, Mar, and Turoff noted that "even three factors do not capture the structure among schizophrenic symptoms. Either more latent variables underlie the intercorrelations among schizophrenic symptoms, or the set of symptoms most often studied is incomplete."[7(p.67)] Peralta and Cuesta[6] have also cogently summarized the limitations of the extant literature, including the need to consider variability in data reduction techniques, the method used for selecting and rotating factors, assessment instruments used, whether items or scale scores are employed in analyses, and the characteristics of the clinical sample studied.

Despite the utilization of different instruments across different patient populations and the application of a variety of factor analytic methods, the one replicable finding has been that negative symptoms emerge as a factor separate from other dimensions of the illness in schizophrenia. Whether 2-, 3-, or 5-factor models are identified, negative symptoms consistently load on a factor separate from positive symptoms, affective symptoms of depression or anxiety, and symptoms of disorganization. Even when more complicated 11-factor models have been identified,[30] negative symptoms stand apart from other symptoms (though blunted affect and asociality-anhedonia separate into correlated factors). With evidence that negative symptoms form a distinct factor within broad assessments of schizophrenic symptomatology, we can next focus our attention on understanding the underlying structure of negative symptoms.

The Structure of Negative Symptoms.

Given that negative symptoms represent a separate dimension of the illness in schizophrenia, the question then arises as to whether negative symptoms are a unitary construct or whether this domain is itself best described as multidimensional. As this larger issue is considered, it is important to note that the various negative symptom scales differ in regard to precise content and number of items included. Excluding global items, the SANS[1,2] currently consists of 19 items (prior versions included an additional item of inappropriate affect[2] that was subsequently dropped[39]), representing 5 rationally derived scales: Affective Flattening or Blunting, Alogia, Avolition-Apathy, Anhedonia-Asociality, and Inattention. The negative symptom scale from the PANSS[3] includes 7 items tapping blunted affect, emotional withdrawal, poor rapport, passive/apathetic social withdrawal, difficulty in abstract thinking, lack of spontaneity and flow of conversation, and stereotyped thinking. The SDS[4] consists of 6 negative symptoms involving restricted affect, diminished emotional range, poverty of speech, curbing of interests, diminished sense of purpose, and diminished social drive.

One issue to consider in looking at these different items or subscales is whether they truly represent different (though correlated) aspects of the negative symptom construct. If negative symptoms are indeed multidimensional, this would indicate the need to ensure broader assessment of these multiple domains and may suggest that these aspects of negative symptoms may have unique etiological, functional, or treatment correlates. Alternatively, if a single factor were to emerge, this could indicate an opportunity to simplify assessment with a focus on a smaller set of representative items.

As has been noted, a variety of instruments are available to assess negative symptoms. However, factor analytic work that exclusively examines the structure of negative symptoms has largely focused on the SANS. The attention given to this measure likely arises from the fact that this was the earliest instrument to measure negative symptoms. Additionally, the SANS represents a larger number of items (20 originally, 19 in the current version) versus some other instruments (eg, the PANSS includes 7 negative symptom items), and thus the SANS may provide more interpretable factor findings. Factor analyses on the SDS[4] are not yet available, as this instrument typically focuses on the generation of dichotomous classification into deficit and nondeficit subtypes rather than dimensional ratings of symptoms. The current review will focus on studies examining the structure of the SANS.

In the first reported CFA examining the structure of the SANS within schizophrenia, Keefe et al.[40] found support for a 3-factor model involving diminished expression, social dysfunction, and disorganization. While suggestive of a multidimensional nature of negative symptoms, this study is limited in that only 13 of the original 20 SANS items were included, so that a previous 2-factor model (obtained using principal component

analysis) identified by Liddle[18] could be directly tested. Additionally, the items used in the CFA included "inappropriate affect," which has been dropped from later versions of the SANS[41] because it is conceptually inconsistent with the construct of negative symptoms. Thus, while suggestive, the findings of Keefe et al.[40] are limited in understanding the structure of the full range of symptoms assessed by the SANS.

Using CFA, Peralta and Cuesta[42] examined the full 20-item version of the SANS within a sample of schizophrenia patients. They concluded that a model based on the original 5, empirically derived scales fit "reasonably well" and that the best-fitting model involved trimming the "inappropriate affect" item. Although support for 5 factors was obtained, results also indicated high intercorrelations among some of the factors, with the highest correlations obtained between Affective Flattening and Alogia (.76) and between Anhedonia-Asociality and Avolition-Apathy (.69). Importantly, Sayers, Curran, and Mueser[43] observed that none of the models tested by Peralta and Cuesta[42] fit well, with even the best models having high χ^2:*df* ratios and fit indices less than the recommended cutoff of .90.[44,45] Additionally, Sayers, Curran, and Mueser[43] noted that the 5-factor model involved a factor with 2 indicators, and models with 2 indicators tend to be unstable.[46,47]

In the most comprehensive study of the SANS to date, Sayers, Curran, and Mueser[43] examined the structure of negative symptoms within a large sample of schizophrenia patients ($N = 457$) over 2 assessments. They utilized CFA and EFA to test various models. An examination of the original 5-factor structure using CFA yielded poor fit. A subsequent EFA on the data yielded 3 factors (replicating an earlier EFA on a subset of these subjects reported by Mueser et al.[41]) corresponding to Diminished Expression (including items from the Affective Flattening or Blunting scale, as well as the "poverty of speech" item), Inattention-Alogia (which included items from the Inattention and Alogia scales, as well as the "poor eye contact" item), and Social Amotivation (reflecting items from the Anhedonia-Asociality and Avolition-Apathy subscales). Subsequent CFA was used to cross-validate the EFA within the same sample at a second assessment. A 3-factor model was supported with 3 correlated factors involving Diminished Expression, Inattention-Alogia, and Social Amotivation. Factor intercorrelations were .83 for Diminished Expression and Inattention-Alogia factors, .56 between Inattention-Alogia and Social Amotivation, and .56 between the Diminished Expression and Social Amotivation factors. Validity analyses indicated that the Social Amotivation factor had unique correlates with independent ratings of social functioning and treatment outcome.[43]

In an EFA of the SANS in schizophrenia, Kelley, van Kammen, and Allen[48] examined the factor structure of negative symptoms while patients were on and off medication. Using the 20-item SANS, 2 factors emerged across assessments: Affective Flattening (involving items from the Affective Flattening or Blunting scale, as well as the "poverty of speech" item) and Diminished Motivation (including items from the Avolition-Apathy and Anhedonia-Asociality scales). Other factors that emerged inconsistently across assessments were related to what the authors described as disorganization items, including social inattentiveness, blocking, latency of response, poverty of content, inattentiveness during mental testing, and inappropriate affect. Interestingly, the use of inattentiveness, poverty of content, and inappropriate affect have raised questions in other factor studies.[eg,43]

In summary, an accumulation of factor analytic studies have demonstrated that the structure of negative symptoms is not unidimensional. Multidimensional models have been indicated in both EFA and CFA. The precise number of factors that best represents negative symptoms (as measured by the SANS) is somewhat unclear; however, the most reliable domains to emerge appear to relate to diminished expression and a combined anhedonia-asociality factor. Factors reflecting diminished expression and anhedonia-asociality have consistently emerged in CFA analyses[42,43,49] and EFA analyses of the SANS.[48] These 2 negative symptom factors also emerged in an EFA of the combined SANS/SAPS.[30]

Data further suggest that a 3-factor model might be more parsimonious than the rationally derived 5 factors of the SANS.[43] However, the Inattention-Alogia factor obtained by Sayers, Curran, and Mueser[43] was highly correlated with the Diminished Expression factor ($r = .83$). The reasons for this high intercorrelation are unclear, but items such as poverty of speech (which had dual loading with Diminished Expression and Inattention-Alogia) and increased latency of response (with a somewhat elevated loading on Diminished Expression) may relate to general decreased expressivity. The inclusion of inattention in ratings of negative symptoms is also somewhat problematic, as questions have been raised as to whether attentional problems are indeed conceptually related to the negative symptom construct.

It is interesting to speculate about the implications for the 2-factor model of negative symptoms with regard to intervention studies. Since the Diminished Expression factor reflects behaviors evident during direct observation within a clinical interview, one might expect these behaviors to show a different time course of response compared with the anhedonia-asociality symptoms that reflect more global social engagement occurring in the community. Specifically, changes in expressivity observed during an interview might be more quickly evident compared with improvement in the number and quality of social relationships developing within the community (which presumably would improve more slowly as the development of relationships depends on complex changes in long-standing social networks). Along similar lines, it

is possible to parse the Anhedonia-Asociality factor to determine if changes in interest, drive, or anticipated pleasure in social interactions appear earlier during an intervention than actual social success.

Dimensions and Subtypes

As one considers the structure of negative symptoms, an inevitable question that arises is if this domain is best considered a pure dimension with individuals varying in degree of severity, or if there is a distinct subtype of negative symptom schizophrenia. This latter categorical model is reflected in typological assignments that can be obtained with clinical rating scales[2,3] and in the "Deficit Syndrome," which explicitly adopts a model that enduring, primary negative symptoms (or deficit symptoms) reflect a distinct subtype of schizophrenia.[50,51] The reviewed factor analytic studies do not address whether a categorical distinction may characterize negative symptoms. Blanchard, Horan, and Collins[52] utilized taxometric statistical procedures[53] to determine if negative symptoms are purely dimensional or if a latent class (or taxon) was also a feature of these symptoms. Taxometric analyses yielded findings consistent with a latent class of negative symptom schizophrenia with a base rate of approximately 28% to 36%. Compared with the other schizophrenia patients, members of this latent class or taxon were more likely to be male and to have poorer social functioning. The results of this study suggest that negative symptoms may be informative in delimiting the phenotypic heterogeneity of schizophrenia and may allow for the identification of a subtype for further study regarding etiological mechanisms and targets for treatment.

Summary

As with factor analyses conducted on broader domains of symptoms, the interpretability of results examining the structure of the SANS is limited by a variety of methodological and conceptual issues. Studies have varied greatly in the samples studied, whether items or subscale scores are analyzed, which items are excluded or later trimmed (with studies examining 13, 18, 19, and 20 SANS items), and how SANS assessments were conducted. Investigators[eg43,54] have emphasized these limitations in addition to noting that important issues, such as the distinction between primary and secondary negative symptoms,[50] were not addressed when utilizing the SANS. Other important issues concern the source of information and time frame sampled. As noted by Sayers, Curran, and Mueser,[43] SANS ratings in their study focused only on the week prior to the interview and relied exclusively on patient reports and observations during the interview (deviating from Andreasen's[39] recommendation that ratings should ideally be based on multiple sources of information). What role broader time frames and more extensive assessments (involving family or the observations of other treatment providers[55]) might have on the obtained structure is unclear but may be relevant in considering the interpretability and generalizability of these findings.

Conceptual issues regarding assessment are also important in the interpretation of findings obtained with current instruments. In looking at the negative symptom factors of diminished expression and anhedonia-asociality, a variety of interpretations are available to explain what may underlie these domains. One might conjecture that these factors reflect underlying processes associated with the illness.[43] Thus, the factor of diminished expression may emerge from the deficits in emotional expression that have been identified in laboratory paradigms,[eg,56–59] while the anhedonia-asociality domain may reflect the separate domain of the experiential aspects of emotion in schizophrenia, including the reduced capacity to experience pleasure.[60,61] An alternative interpretation is that these 2 factors reflect measurement influences unrelated to distinct processes that are related to the illness or more broadly to emotion. Items reflecting diminished expression or blunted affect may cohere because they are all related to behavioral observations of interpersonal expression observed during the interview (decreased eye contact, paucity of gestures, lack of facial expression or vocal intonation). With regard to anhedonia-asociality items, as summarized in this issue by Horan, Kring, and Blanchard,[62] it may be problematic to interpret these items as indicators of emotional experience. Rather, anhedonia-asociality items may aggregate as a separate factor because they tap general social activity outside of the interview that is largely based on patients' self-reports (recreational interests, sexual interest and activity, ability to feel intimacy, and relationships with peers and family).

A critical issue in considering this literature is the mundane but important fact that factor analytic solutions depend on the variables used in analyses.[6,7] Results will relate to the number of symptoms assessed, as well as basic psychometric properties of input variables, including the reliability of individual symptoms that comprise the scales. The above factor solutions are constrained by reliance on the SANS. As noted by Smith, Mar, and Turoff,[7] although there may be consensus about what symptoms should be studied in the assessment of schizophrenic symptomatology, consensus does not ensure comprehensiveness. For example, Horan, Kring, and Blanchard[62] make the case that our current understanding of anhedonia-asociality may be severely constrained by instrument limitations, including a potential failure to adequately address experiential deficits independent from behavioral achievements. While the available evidence clearly supports a multidimensional structure of negative symptoms, the development of more extensive assessment instruments may very well yield a different latent structure.

Based on current findings, it will be informative to either modify current negative symptom scales or develop entirely new items and assess the impact of these modifications on structural findings and external correlates. One strategy would be to disaggregate complex items or scales into component parts so that precision of measurement can be enhanced. For example, items can be modified to more accurately assess the potentially distinct domains of anhedonia (as this relates to actual emotional experience) and asociality (as relating to behavioral indicators of social activity).[62] As content is reviewed for the development of new items, it may be particularly fruitful to consider the literature from basic research on emotion and social behavior. The performance of modified assessment scales can then be examined with regard to their structural and external validity.[5]

Conclusions

An accumulation of evidence supports the structural validity of negative symptoms. In broad assessments of schizophrenic symptomatology, negative symptoms have repeatedly emerged as a separate factor, independent of positive symptoms, disorganization, and affective symptoms, including depression and anxiety. Additional research focusing on the latent structure of negative symptoms themselves suggests that this symptom domain is not unidimensional. The most reliable factors to emerge within negative symptoms include diminished expression (typically involving symptoms of reduced facial and vocal expressivity and reduced verbal output) and a factor tapping anhedonia and asociality (composed of symptoms of anhedonia, diminished interest, and decreased social engagement). Other factors may involve aspects of alogia and inattention. Although these factors were replicable, serious limitations were noted in this literature. Thus, 2- (or even 3- or 5-) factor models should not be considered definitive, but rather all converge to support the general conclusion of the multidimensionality of negative symptoms. The later findings indicate the importance of employing assessments that provide adequate coverage of the broad domain of negative symptoms. Importantly, a number of limitations in our current understanding of the structure of negative symptoms were noted, including potentially critical issues in how symptoms are assessed. The current findings may help to inform the development of future instruments for the assessment of negative symptoms.

Acknowledgments

Preparation of this article was supported by Grant MH-51240 from the National Institute of Mental Health (Dr. Blanchard).

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