Validation of the Brief Negative Symptom Scale and its association with functioning

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Abstract

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Introduction

The Brief Negative Symptom Scale (BNSS) includes five domains of negative symptoms suggested by the NIMH Consensus Development Conference (anhedonia, asociality, avolition, blunted affect, and alogia), which could be clustered into two factors— Motivation-Pleasure (MAP) and Emotional-Expressivity (EE). Our study aims to examine the psychometric properties of BNSS, and its association with functioning.

Methods

274 individuals with schizophrenia were assessed on the BNSS, Positive and Negative Syndrome Scale (PANSS), Scale for the Assessment of Negative Symptoms (SANS), Global Assessment of Functioning Scale (GAF), Calgary Depression Scale for Schizophrenia (CDSS), and Simpson-Angus Extrapyramidal Side Effects Scale (SAS). Internal consistency was examined using Cronbach's alpha. Concurrent, discriminant, and construct validity were examined. Factor structure of BNSS was explored using confirmatory factor analyses. Association between GAF and BNSS was examined with GAF as the dependent variable and BNSS Total, MAP and EE, and BNSS five domains as independent variables in three multiple regression models after controlling for covariates.

Results

BNSS showed good internal consistency (Cronbach's alpha=.880) and validity. The five-factor model fit the data better than the two-factor model; a second-order model was superior to both models. More severe symptoms on BNSS Total (B=-.438, p<.001), MAP (B=-.876, p<.001), Avolition (B=-2.503, p<.001) and Asociality (B=-.950, p=.001) were associated with lower GAF.

Conclusion

Our results lend support to the use of BNSS in clinical practice and in future research into negative symptoms. Composite scores could be computed using either the five-factor or second-order models. Negative symptoms, particularly MAP, avolition and asociality, were associated with functioning.

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1. Introduction

Negative symptoms are regarded as one of the core symptoms of schizophrenia psychopathology. They are associated with social and occupational impairment (Erickson, Jaafari, & Lysaker, 2011; Liddle, 1987; Milev et al., 2005; Rocca et al., 2014), illness relapse, higher rate of re-hospitalization (Dyck et al., 2000; Herbener & Harrow, 1997), and lower subjective quality of life (Dyck et al., 2000). To date, pharmacological treatment and psychosocial intervention have shown at most modest treatment efficacy in managing negative symptoms (Cella et al., 2017; Chue & Lalonde, 2014; Erhart, Marder, & Carpenter, 2006; Fusar-Poli et al., 2015; Velligan et al., 2015). The most commonly used scales to assess negative symptoms, the Scale for the Assessment of Negative Symptoms (SANS) and the Positive and Negative Syndrome Scale (PANSS), were developed in the 1980s (Andreasen, 1982; Kay, Fiszbein, & Opler, 1987), and might not reflect recent developments that incorporate not only behavioral manifestations of negative symptoms but also inner drives of behavior, as well as both consummatory and anticipatory anhedonia (Kirkpatrick, 2014; Marder & Galderisi, 2017). Recognizing the treatment gap and limitations of available scales, new generation negative symptom measures have been developed.

Negative symptoms are multi-dimensional (Blanchard & Cohen, 2005); a conference held by NIMH in 2005 reached a consensus that domains of negative symptoms include anhedonia, asociality, avolition, blunted affect, and alogia (Kirkpatrick et al., 2006). Two workgroups were formed, one of which developed the Brief Negative Symptom Scale (BNSS; (Kirkpatrick et al., 2011), which is concise and practical for clinical use, covering all domains of negative symptoms. The BNSS was shown to have good reliability and validity (Bischof et al., 2016; Kirkpatrick et al., 2011; Mané et al., 2014; Mucci et al., 2015; Polat Nazlı et al., 2016; Strauss, Keller, et al., 2012). The five domains of negative symptoms were proposed to cluster into two factors—anhedonia, asociality and avolition belong to the Motivation-Pleasure (MAP) factor; blunted affect and alogia belong to the Emotional Expressivity (EE) factor (Marder & Galderisi, 2017). Factor analyses on the BNSS in most studies showed two factors (Kirkpatrick et al., 2011; Mucci et al., 2015; Polat Nazlı et al., 2016; Strauss, Hong, et al., 2012), while a study conducted in Spain suggested a three-factor solution (Garcia-Portilla et al., 2014). More recently, another study using

samples from five cultures and languages suggested that a five-factor structure and a hierarchical structure with the five domains as first order factors and EE and MAP as second-order factors were valid, with the five-factor model being slightly better (Ahmed et al., 2018). Different mechanisms, cognitive models and neural correlates were suggested to have accounted for the MAP and EE factors (Kaiser et al., 2017), which might have important implications for treatment in schizophrenia. Therefore, it is important to investigate and validate the domains of negative symptoms to foster future research aimed at developing effective intervention for people with schizophrenia.

The first aim of this study is to examine the reliability, validity, and factor structure of the BNSS in an Asian population. Since most previous studies suggested a two-factor model (Kirkpatrick et al., 2006, 2011; Mucci et al., 2015; Polat Nazlı et al., 2016; Strauss, Hong, et al., 2012) while Ahmed et al. (2018) suggested a five-factor model and a hierarchical model integrating both two-factor and five-factor structure, we investigate how well our data fit the two-factor, five-factor, and second-order models. The second aim of this study is to explore the association of negative symptoms assessed on the BNSS and functioning.

2. Materials and methods

2.1. Study setting and participants

Individuals diagnosed with schizophrenia, aged 21-65 and able to speak English, were recruited from the outpatient clinics at the Institute of Mental Health, Singapore. Individuals with current alcohol or substance use disorder, history of brain injuries, neurological disorder or mental retardation were excluded. The Structured Clinical Interview for DSM-IV-TR Axis I Disorder-Patient Edition (SCID-I/P: First et al., 2002) was used to ascertain the diagnosis of schizophrenia. A total of 274 individuals participated in the study. All participants provided written informed consent to participate in the study. The study was approved by the National Health Group's Domain Specific Review Board.

2.2. Assessments

All participants were assessed on the BNSS (Kirkpatrick et al., 2011), PANSS (Kay et al., 1987), SANS (Andreasen, 1982), Calgary Depression Scale for Schizophrenia (CDSS: Addington, Addington, & Schissel,

1990), Global Assessment of Functioning Scale (GAF: American Psychiatric Association, 2000; First et al., 2002), and Simpson-Angus Extrapyramidal Side Effects Scale (SAS: Simpson & Angus, 1970). Demographic information was collected.

BNSS comprises six subscales measured by 13 items, rated from "0: No impairment" to "6: Severe deficit". Besides the five negative symptom domains, an item inquiring an individual's ability to experience normal distress formed the Distress subscale. Ratings of items on the BNSS Anhedonia subscale, Asociality subscale, and Avolition subscale were summed to form the MAP factor, and sum of ratings on the Blunted Affect subscale and Alogia subscale formed the EE factor.

PANSS measures positive and negative symptoms of schizophrenia, and consists of 30 items rated from "1: Absent" to "7: Extreme". A local study reported a five-factor PANSS model which consisted of positive symptoms, negative symptoms, excitement, depression, and cognition (Jiang, Sim, & Lee, 2013). With reference to this model, PANSS items P1, P3, P6 and G9 were summed to form PANSS Positive; N2, N3, N4, N6 and G7 were summed to form Negative; P4, P7 and G14 were summed to form Excitement; G2, G3 and G6 were summed to form Depression; and G10 and G12 were summed to form Cognition. Different items have been suggested to constitute a specific factor in PANSS, e.g., G10 and G12 were included in "disorganization" in some PANSS models (Anderson et al., 2018; Dragioti et al., 2017; Kelley et al., 2013; van der Gaag et al., 2006) and "Cognition" in others (Dragioti et al., 2017; Lancon et al., 1998; Lindenmayer, Grochowski, & Hyman, 1995; Walsh-Messinger et al., 2018); while some reported "disorganization/cognition" as one of the PANSS factors (Higuchi et al., 2014; Wallwork et al., 2012). PANSS model suggested by Jiang, Sim, & Lee (2013) was similar to a consensus model suggested by Wallwork et al. (2012), with the exception of a factor termed "Cognition" was suggested by the former, and a "Disorganization/Concrete" factor constituting P2, N5, and G11 by the latter. We conducted analyses with the local PANSS model and the consensus PANSS five-factor model proposed by Wallwork et al. (2012).

SANS is a 25-item negative symptoms measure, consisting of five subscales—Affective Flattening, Alogia, Avolition-Apathy, Anhedonia-Asociality, and Attention. It also includes a global rating item for each of the subscales. Symptom severity was rated on a six-point scale from "0: Not at all" to "5: Severe". The items "Inappropriate affect" and "Poverty of content of speech" and the Attention subscale have been reported to load onto the disorganized factor in SANS (Andreasen, 1982; Liddle, 1987; Miller, Arndt, &

Andreasen, 1993; Sayers, Curran, & Mueser, 1996) and were therefore excluded in the computation of any subscale scores. The ratings of all items in each subscale (excluding the global rating item) were summed to form the SANS subscale scores, while the SANS Total was derived from the summation of all subscale scores.

GAF measures symptoms and functioning rated from 0-100; higher rating indicates lower symptom severity and better functioning. CDSS assesses severity of symptoms of depression on 9 items, rated from "0: Absent" to "3: Severe". SAS measures extrapyramidal side effects on 10 items, rated on a five-point scale from 0-4, with "0" denoting normal and "4" denoting severe side effects. Scores of CDSS and SAS were computed by summing the ratings of all items.

Three raters, including one research clinician, one master level research psychologist and one bachelor level research psychologist, were trained prior to the assessments. All raters had at least 2 years' experience in administering psychiatric rating scales on individuals with schizophrenia. The intra-class correlation coefficient (ICC) between raters during training was good (>.80) for BNSS and PANSS. Case discussions and supervision were held twice a month to ensure adequate understanding and agreement in rating.

2.3. Statistical Analyses

2.3.1. Reliability

Internal consistency of the BNSS, its subscales and the MAP and EE factors were examined using the Cronbach's alpha test.

2.3.2. Validity

Concurrent validity was examined by Spearman's correlation between BNSS (Total and its subscales) and PANSS Negative, SANS Total, and all SANS subscales except SANS Attention subscale. Discriminant validity was investigated by Spearman's correlation between BNSS (Total and its subscales) and PANSS Positive, PANSS Excitement, PANSS Depression, PANSS Cognition, SANS Attention subscale, CDSS, and SAS. Construct validity was explored using Spearman's correlation between BNSS subscales and BNSS

MAP and EE factors, as well as confirmatory factor analyses (CFA). CFAs were conducted to understand how well the data fit the two-factor, five-factor, and second-order models. In the second-order model, Anhedonia, Asociality, Avolition, Blunted Affect, and Alogia were first-order factors and MAP and EE were second-order factors. Models with root mean square error of approximation (RMSEA) <0.08, comparative fit index (CFI) >0.95, the Tucker-Lewis Index (TLI) >0.95, and weighted root mean residual (WRMR) <1.0 were deemed as having a good fit (Cook, Kallen, & Amtmann, 2009; Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999; Yu, 2002).

2.3.3. Multiple Linear Regression

Multiple linear regression analyses were conducted with GAF as the dependent variable and either BNSS Total, BNSS MAP and BNSS EE, or BNSS scores computed from the five domains as independent variables, controlling for age, sex, education, duration of illness, antipsychotic doses, and PANSS factors (except PANSS Negative). Three models were conducted with PANSS factors derived from Jiang et al. (2013) and another three with the consensus model (Wallwork et al., 2012).

CFAs were conducted using M-plus version 7.4, all other statistical analyses were performed using IBM SPSS Statistics 23.

3. Results

3.1. Socio-demographic and clinical characteristics of the sample

Characteristics of the study sample are presented in Table 1. Most participants (n=109, 39.8%) were rated on the GAF as having moderate symptoms and/or moderate difficulties in social and/or occupational functioning, 29.9% (n=82) of them were categorized as having serious symptoms and/or serious impairment in functioning, and 13.9% (n=38) of them having mild symptoms and/or mild impairment in functioning.

3.2. Internal Consistency of the BNSS

The descriptive statistics and item-total correlations of the BNSS are presented in Table 2. The 13-item BNSS had good internal consistency (Cronbach's alpha=.880). Cronbach's alpha was lower if any item was deleted from the 13-item BNSS. Cronbach's alpha values of subscales ranged from .848 to .949. For MAP, excluding the Distress item resulted in the increment of Cronbach's alpha from .876 to .898; for EE, excluding Distress increased Cronbach's alpha from .863 to .878. Nevertheless, the changes in Cronbach's alpha after removing Distress were small (range: .004-.022).

3.3. Validity of the BNSS

Table 3 shows Spearman's correlations between BNSS subscales, and between BNSS and all other scales. At scale level analyses, Spearman's correlations between BNSS Total, SANS Total and PANSS Negative were high. At subscale level analyses, Spearman's correlations between subscales measuring the same construct in BNSS and SANS (e.g., BNSS Blunted Affect and SANS Affective Flattening) were high, while the correlations between relevant subscales were moderately high (e.g., BNSS MAP and SANS Avolition-Apathy; BNSS Alogia and SANS Affective Flattening; BNSS Avolition and BNSS Anhedonia). These indicated that BNSS had good concurrent validity.

Discriminant validity was demonstrated by moderately low to negligible correlations between BNSS scores and SAS, CDSS, SANS Attention, and all PANSS factors except PANSS negative. Furthermore, the moderately low correlations between subscales across the MAP and EE factors (e.g. BNSS EE and SANS Anhedonia-Asociality; BNSS Alogia and SANS Avolition-Apathy; BNSS Anhedonia and BNSS Blunted Affect) also provided support for discriminant validity. The highest associations were found between BNSS EE and SAS (r_s=.357, p<.01), BNSS Blunted Affect and SAS (r_s=.341, p<.01), BNSS EE and PANSS Cognition (r_s=.328, p<.01), and BNSS Alogia and PANSS Cognition (r_s=.369, p<.01). PANSS factors derived from Jiang et al. (2013) and Wallwork et al. (2012) had similar correlations with the BNSS (See supplementary Table 6).

The validity of BNSS Distress was supported by significant modest correlation with CDSS (r_s=-.330, p<.01), PANSS Depression (r_s=-.422, p<.01) and PANSS Excitement (r_s=-.346, p<.01), and its low correlations with SAS, PANSS Positive, and SANS Attention. Distress subscale did not have strong correlations with other subscales in BNSS MAP (r_s=.163-.290, all p<.01) and BNSS EE (r_s=.292 and r_s=.360, both p<.01), and

appeared more relevant to EE (r_s=.365, p<.01) than MAP (r_s=.315, p<.01). MAP was moderately correlated with EE (r_s=.367, p<.01).

3.4. Confirmatory Factor Analysis of the BNSS

As a latent factor in CFA could not be represented by only one item, the Distress item was either regressed on the MAP factor or the EE factor in two-factor models, regressed on Anhedonia, Asociality, Avolition, Blunted Affect or Alogia in five-factor models and second-order models, or not included in the CFA models. CFA with BNSS items 1-3 and 5-8 regressed on the MAP factor, and BNSS items 9-13 regressed on the EE factor yielded good CFI and TFI indices (CFI=.965, TFI=.956) but unsatisfactory RMSEA (RMSEA=.170, CI=.156-.184). CFA with the five BNSS subscales (Anhedonia, Asociality, Avolition, Blunted Affect, and Alogia) yielded good CFI and TFI indices and a better RMSEA (CFI=.998, TFI=.997, RMSEA=.043, CI=.019-.064). A second-order model with Anhedonia, Asociality, Avolition, Blunted Affect and Alogia as first order factors and MAP and EE as second-order factors was then examined (see supplementary Figure 1). In this model, Anhedonia, Asociality, and Avolition were correlated with MAP, and Blunted Affect and Alogia correlated with EE. This model yielded CFI=.999, TFI=.998, and RMSEA=.035 (CI=0.000 - 0.056). The fit indices are shown in Table 4.

3.5. Association between BNSS and GAF

GAF was significantly associated with BNSS Total (B=-.438, p<.001), MAP (B=-.876, p<.001), Asociality (B=-.950, p=.001) and Avolition (B=-2.503, p<.001). The association between GAF and Blunted Affect was marginally significant (B=-.201, p=.077). The associations between GAF and other BNSS scores were not significant. Results were similar when Wallwork et al. (2012) PANSS model was used (See Supplementary Table 7).

GAF was also significantly associated with PANSS Positive (B=-.584, p<.001) and PANSS Depression (B=-.427, p=.046) in the multiple regression model with BNSS Total, with PANSS Positive (B=-.573, p<.001) and PANSS Cognition (B=-.760, p=.013) in the BNSS two-factor model, and with PANSS Positive (B=-.584, p<.001) and PANSS Cognition (B=-.702, p=.017) in the BNSS five-factor model. The association between GAF and PANSS Cognition was marginally significant (B=-.590, p=.072) in the model with BNSS Total (see Table 5).

4. Discussion

This study aimed to examine the reliability, validity, and factor structure of the BNSS, as well as the association between BNSS and functioning. The results suggested that the BNSS had good internal consistency and validity. Significant high correlations were found between BNSS Total, its subscales and the scales measuring the same constructs, while low to negligible correlations were observed between BNSS and the scales measuring different constructs. The adequate model fits of both five-factor and second-order models supported the recent conceptualization of negative symptoms. The associations between BNSS scores and GAF also supported predictive validity of the BNSS, while providing further insights about the associations between specific domains of negative symptoms and functioning.

Model fit indices indicated that both five-factor and second-order models fit the data, of which the second-order model had the best fit. The results supported the conceptualization of negative symptoms suggested by the NIMH consensus development conference (Kirkpatrick et al., 2006), and the recent evidence on negative symptom structure (Ahmed et al., 2018). In Ahmed et al. (2018)'s report, the fit indices of both five-factor and second-order models were adequate in most samples, except for the Chinese sample (RMSEA>.10 in both models). Our sample comprised 84% Chinese ethnicity with similar age and gender composition and our data showed good fit in both five-factor and second-order models. Although the interview was conducted in English and our sample consisted of only outpatients, our results supported both the five-factor and second-order models.

The significant association found between BNSS and GAF is consistent with previous studies (Erickson et al., 2011; Pogue-Geile & Harrow, 1985; Rocca et al., 2010; Shamsi et al., 2011). Negative symptoms measured as one factor, two factors or five factors would result in different understanding and interpretation of the roles of negative symptoms in clinical setting. In our study, negative symptoms indicated by the two-factor conceptualization showed that MAP but not EE was associated with GAF, while negative symptoms indicated by five domains showed that avolition and asociality were associated with GAF. This is consistent with previous studies (Foussias & Remington, 2010; Rocca et al., 2014) that MAP was more relevant to functioning than EE. The moderately low association between MAP and EE suggested that MAP and EE were related but distinct constructs. Ventral striatal activation was inversely

associated with MAP but not with EE during a reward anticipation task, suggesting that MAP and EE have different underlying neurobiological mechanisms (Kirschner et al., 2016). On the other hand, EE, but not MAP, was significantly associated with cognition (Hartmann-Riemer et al., 2015). Similar observations in the literature suggested that investigation by domain would be important. Kiwanuka et al. (2014) showed that self-reported social anhedonia was associated with social functioning but not work functioning. Similarly, Robertson et al. (2014) showed that asociality was uniquely associated with social functioning, independent of social competence and other negative symptoms as measured on the PANSS. Avolition was also shown to be associated with functioning in schizophrenia (Galderisi et al., 2014). Associations of different factors and neurology correlates with negative symptom domains could be further clarified when a more sophisticated symptom structure is used. The potential uses of the factor scores derived from the hierarchical model would be important in future research, e.g., to further investigate the associations between negative symptoms and social cognition where mixed findings have been found (Marder & Galderisi, 2017).

Consistent with previous studies, besides negative symptoms, cognitive, depressive, and positive symptoms were also associated with functioning in our study (Bowie et al., 2008, 2006; Galderisi et al., 2014; Harvey et al., 2006; Milev et al., 2005; Robertson et al., 2014; Shamsi et al., 2011; Stouten et al., 2017). However, significant association between GAF and PANSS Depression was only demonstrated in the model with BNSS Total. This is in line with Robertson et al. (2014) where depression significantly but minimally improved prediction of social functioning.

Modest correlations were observed between PANSS Cognition and BNSS EE, BNSS Blunted Affect, BNSS Alogia, BNSS Asociality and BNSS Distress. Similar correlations were observed on SANS Attention with BNSS MAP and BNSS EE. The strength of associations of BNSS Total with SANS Attention (r_s=.282, p<.01) and PANSS Cognition (r_s=.319, p<.01) in our study were similar to those shown in Strauss et al. (2012), in which correlation coefficients of processing speed, attention/vigilance and working memory with BNSS Total ranged between r=-0.21 to r=-.36. The EE factor has also been reported to be correlated with Speed/Vigilance factor in which an attention neurocognitive test was one of the factor component in a local study (Lim et al., 2016). These correlations also supported the validity of BNSS EE, BNSS Blunted Affect, and BNSS Alogia as EE was shown to be associated with cognition (Hager et al., 2015; Hartmann-Riemer et al., 2015). Nevertheless, the magnitude of these associations was relatively low, and the

significance level obtained in our study is largely due to the large sample size (Harmatz & Greenblatt, 2015).

Social withdrawal may be secondary to positive symptoms like paranoia and hallucination and depression (Marder & Galderisi, 2017). However, weak or negligible correlations between BNSS Asociality and PANSS Positive, CDSS and PANSS depression suggested that they are different constructs. The shared variance of asociality with depression and positive symptoms was not pronounced in our sample. The modest correlation between BNSS EE and SAS indicated that medication side effects might resemble affective flattening (Carpenter, Heinrichs, & Alphs, 1985; Kelley, Van Kammen, & Allen, 1999).

Reliability analysis showed that discarding Distress from the 13-item BNSS resulted in a lower Cronbach's alpha, but a higher Cronbach's alpha for MAP and EE. Cronbach's alpha is affected by the length of a scale; if a scale consists of sufficient items, the Cronbach's alpha could be substantial even if the scale contain more than one construct (Streiner, 2003; Tavakol & Dennick, 2011). This may explain the slight drop in the Cronbach's alpha when Distress was excluded from the 13-item BNSS. Distress had low associations with MAP and EE and might not be closely related to MAP or EE; this may explain the slight increase in Cronbach's alpha for MAP and EE when Distress was excluded. The BNSS developers opined that this affective item could be a predictor of deficit schizophrenia (Strauss, Keller, et al., 2012). However, the loading of this item in exploratory factor analyses have not been consistent (Kirkpatrick et al., 2011; Mucci et al., 2015; Strauss, Hong, et al., 2012). It was shown to be more relevant to the EE factor in most studies (Kirkpatrick et al., 2011; Polat Nazlı et al., 2016; Strauss, Hong, et al., 2012), had higher loading on the MAP factor in an Italian sample (Mucci et al., 2015), and was not included in principal component analysis due to low communalities in a Spanish study (Garcia-Portilla et al., 2014). In our sample, this item had higher correlation with EE than MAP. The negligible to moderately low correlations of this item with other negative symptom subscales (r_s=.140-.365, all $p<.05$) suggested that Distress might explain some variance in negative symptoms but might not be a measure of negative symptoms. The inclusion of Distress in CFA models also consistently resulted in worse fit indices. The utility of this item in distinguishing deficit schizophrenia subgroup requires further investigation.

This study has some limitations. The study recruited only outpatients living in the community and nursing homes, thus generalizability of the study results to people with more severe symptoms is unknown. As our study participants were relatively stable and well-maintained, the range of symptoms

severity rating was limited. GAF measures both functioning and symptom severity, therefore the association of PANSS and BNSS with GAF would be affected by the symptom severity component of GAF in multiple linear regression analyses. The data is cross-sectional, thus test-retest reliability could not be examined. Furthermore, all scales were rated by the same rater, which could result in higher correlations between different negative symptom scales. Our study did not explore neurobiological, cognitive, or social correlates of negative symptoms, which could be investigated in future studies to further validate the conceptual domains of negative symptoms and the psychometric properties of the BNSS for use in future clinical trials and intervention studies.

To our knowledge, this is the first validation of BNSS conducted with English speaking Asian participants. Our study had a big sample size to enable relatively reliable factor analyses. In conclusion, our results suggested that BNSS has good reliability and validity. The conceptual domains of negative symptoms suggested by the Consensus development conference (Kirkpatrick et al., 2006) and the validation studies to date (Ahmed et al., 2018; Kirkpatrick et al., 2011; Mucci et al., 2015; Strauss, Hong, et al., 2012) were supported by our data. Our study also suggested that the composite scores computed by adopting either the two-factor or five-factor structure are valid for use for future research. Our results further indicated the different implications when different factor structure was used; in our case, a more refined understanding on negative symptoms and functioning could inform the areas of potential intervention for people with schizophrenia in the future. This is a preliminary study and the results could be a cornerstone for future studies on negative symptoms in the local population or English speaking Asian population.

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Table 1. Demographic and clinical characteristics of participants

Variable	**Mean (SD) or n (%)**
Sex (Male)	152 (55.47%)
Age (year)	40.42 (10.17)
Duration of illness (year)	17.34 (9.64)
Antipsychotic dose*	462.35 (407.65)
Ethnicity	
Chinese	231 (84.31%)
Malay	20 (7.30%)
Indian	22 (8.03%)
Others	1 (0.36%)
Education level	
Primary or lower	44 (16.06%)
Secondary	60 (21.90%)
Pre-University	20 (7.30%)
Certificate/Vocational	50 (18.25%)
Diploma	71 (25.91%)
Degree and above	29 (10.58%)
Marital Status	
Single	213 (77.74%)
Married	35 (12.77%)
Separated/Divorced/Widowed	26 (9.49%)
Employment Status (Employed)	139 (50.73%)
PANSS Total score	58.11 (12.88)
PANSS Positive	8.31 (4.35)
PANSS Negative	11.28 (4.05)
PANSS Depression	5.60 (2.50)
PANSS Excitement	4.60 (2.06)
PANSS Cognition	4.34 (1.64)
SANS Total score (Without SANS Attention)	23.79 (11.50)
SANS Affective Flattening	7.82 (6.60)
SANS Alogia	2.82 (2.42)
SANS Avolition-Apathy	4.99 (3.14)
SANS Anhedonia-Asociality	8.15 (3.90)
SANS Attention	2.27 (1.84)
GAF	53.78 (10.46)
CDSS	2.84 (3.18)
SAS	1.96 (2.71)

*Antipsychotic doses were converted into daily chlorpromazine equivalents

PANSS, Positive and Negative Syndrome Scale; SANS, Scale for the Assessment of Negative Symptoms; GAF, Global Assessment of Functioning Scale; CDSS, Calgary Depression Scale for Schizophrenia; SAS, Simpson-Angus Extrapyramidal Side Effects Scale

Table 2. Descriptive statistics and internal consistency of the BNSS

	Mean	SD	Range	Skewness	Kurtosis	Item-Total Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Motivation-Pleasure	14.493	6.350	0-33	.000	-.411			.898
Anhedonia subscale	7.095	3.485	0-15	-.128	-.787			.906
1. Intensity of pleasure	2.500	1.229	0-5	-.238	-.768	.605	.869	
2. Frequency of pleasurable activities	2.515	1.273	0-5	-.113	-.816	.588	.870	
3. Intensity of expected pleasure	2.080	1.296	0-5	-.018	-.798	.639	.867	
Distress subscale								
4. Distress	.894	1.447	0-6	1.814	2.724	.456	.876	
Asociality	2.821	1.785	0-12	1.027	2.953			.848
5. Asociality: Behaviour	1.599	.949	0-6	.491	1.399	.451	.877	
6. Asociality: Internal experience	1.223	.967	0-6	1.253	3.086	.462	.876	
Avolition	4.577	2.166	0-10	.038	-.327			.873
7. Avolition: Behaviour	2.248	1.134	0-5	.077	-.283	.539	.873	
8. Avolition: Internal experience	2.328	1.165	0-5	-.132	-.415	.635	.868	
Emotional Expressivity	9.529	7.132	0-28	.502	-.544			.878
Blunted Affect	5.427	4.541	0-17	.626	-.544			.876
9. Facial Expression	2.204	1.643	0-6	.293	-.700	.592	.869	
10. Vocal Expression	1.555	1.741	0-6	.855	-.393	.558	.872	
11. Expressive Gestures	1.668	1.689	0-6	.592	-.843	.549	.872	
Alogia	4.102	3.535	0-12	.406	-.977			.949
12. Quantity of Speech	1.759	1.693	0-6	.588	-.664	.647	.866	
13. Spontaneous Elaboration	2.343	1.923	0-6	.288	-1.156	.676	.865	
BNSS Total score	24.916	11.879	1-62	.336	-.559			.880

BNSS, Brief Negative Symptom Scale

Table 3. Validity of the BNSS

	BNSS Anhedonia	BNSS Distress	BNSS Asociality	BNSS Avolition	BNSS Blunted Affect	BNSS Alogia	BNSS MAP	BNSS EE	BNSS Total
BNSS Anhedonia	1.000	.290**	.550**	.658**	.261**	.319**	.937**	.321**	.742**
BNSS Distress	.290**	1.000	.163**	.276**	.292**	.360**	.315**	.365**	.476**
BNSS Asociality	.550**	.163**	1.000	.410**	.189**	.306**	.709**	.274**	.567**
BNSS Avolition	.658**	.276**	.410**	1.000	.253**	.338**	.814**	.327**	.678**
BNSS Blunted Affect	.261**	.292**	.189**	.253**	1.000	.551**	.291**	.912**	.731**
BNSS Alogia	.319**	.360**	.306**	.338**	.551**	1.000	.369**	.838**	.738**
BNSS MAP	.937**	.315**	.709**	.814**	.291**	.369**	1.000	.367**	.802**
BNSS EE	.321**	.365**	.274**	.327**	.912**	.838**	.367**	1.000	.833**
Concurrent Validity: Other Scales									
SANS Affective Flattening	.279**	.276**	.225**	.244**	.947**	.536**	.306**	.871**	.716**
SANS Alogia	.348**	.298**	.343**	.331**	.564**	.822**	.398**	.762**	.700**
SANS Avolition-Apathy	.404**	.140*	.328**	.735**	.268**	.269**	.551**	.308**	.503**
SANS Anhedonia-Asociality	.576**	.186**	.634**	.557**	.241**	.341**	.686**	.321**	.591**
SANS Total	.522**	.322**	.490**	.576**	.796**	.649**	.621**	.833**	.880**
PANSS Negative	.491**	.331**	.549**	.503**	.526**	.816**	.587**	.737**	.793**
Discriminant Validity									
PANSS Positive	.103	-.119*	.223**	.124*	.108	.082	.146*	.108	.132*
PANSS Excitement	-.054	-.346**	.094	.017	-.191**	-.103	-.009	-.169**	-.136*
PANSS Depression	.092	-.422**	-.001	.041	-.008	-.136*	.062	-.077	-.053
PANSS Cognition	.112	.222**	.263**	.198**	.221**	.369**	.194**	.328**	.319**
SANS Attention	.159**	.082	.161**	.240**	.219**	.250**	.215**	.264**	.282**
CDSS	.172**	-.330**	.095	.145*	.009	-.150*	.165**	-.066	.035
SAS	.092	.128*	.143*	.124*	.341**	.276**	.131*	.357**	.297**

BNSS, Brief Negative Symptom Scale; SANS, Scale for the Assessment of Negative Symptoms; PANSS, Positive and Negative Syndrome Scale; CDSS, Calgary Depression Scale for Schizophrenia; SAS, Simpson-Angus Extrapyramidal Side Effects Scale

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4. Fit indices of CFA on the BNSS

	RMSEA	CFI	TFI	WRMR
Two-factor (Distress with MAP)	0.170 (0.157 - 0.183)	0.958	0.949	2.000
Two-factor (Distress with EE)	0.161 (0.148 - 0.174)	0.963	0.955	1.933
Two-factor without Distress	0.170 (0.156 - 0.184)	0.965	0.956	1.956
Five-factor (Distress with Anhedonia)	0.096 (0.082 - 0.111)	0.989	0.984	0.869
Five-factor (Distress with Asociality)	0.108 (0.094 - 0.123)	0.985	0.979	0.970
Five-factor (Distress with Avolition)	0.091 (0.076 - 0.106)	0.990	0.985	0.834
Five-factor (Distress with Blunted Affect)	0.084 (0.069 - 0.099)	0.991	0.988	0.816
Five-factor (Distress with Alogia)	0.064 (0.048 - 0.080)	0.995	0.993	0.668
Five-factor without Distress	0.043 (0.019 - 0.064)	0.998	0.997	0.453
Second-order (Distress with Anhedonia)	0.081 (0.066 - 0.095)	0.991	0.989	0.881
Second-order (Distress with Asociality)	0.098 (0.084 - 0.112)	0.987	0.983	1.028
Second-order (Distress with Avolition)	0.085 (0.070 - 0.099)	0.991	0.987	0.912
Second-order (Distress with Blunted Affect)	0.075 (0.060 - 0.090)	0.993	0.990	0.854
Second-order (Distress with Alogia)	0.055 (0.039 - 0.071)	0.996	0.995	0.697
Second-order without Distress	0.035 (0.000 - 0.056)	0.999	0.998	0.512

BNSS, Brief Negative Symptom Scale

Table 5. Multiple linear regression with BNSS scores and covariates on GAF

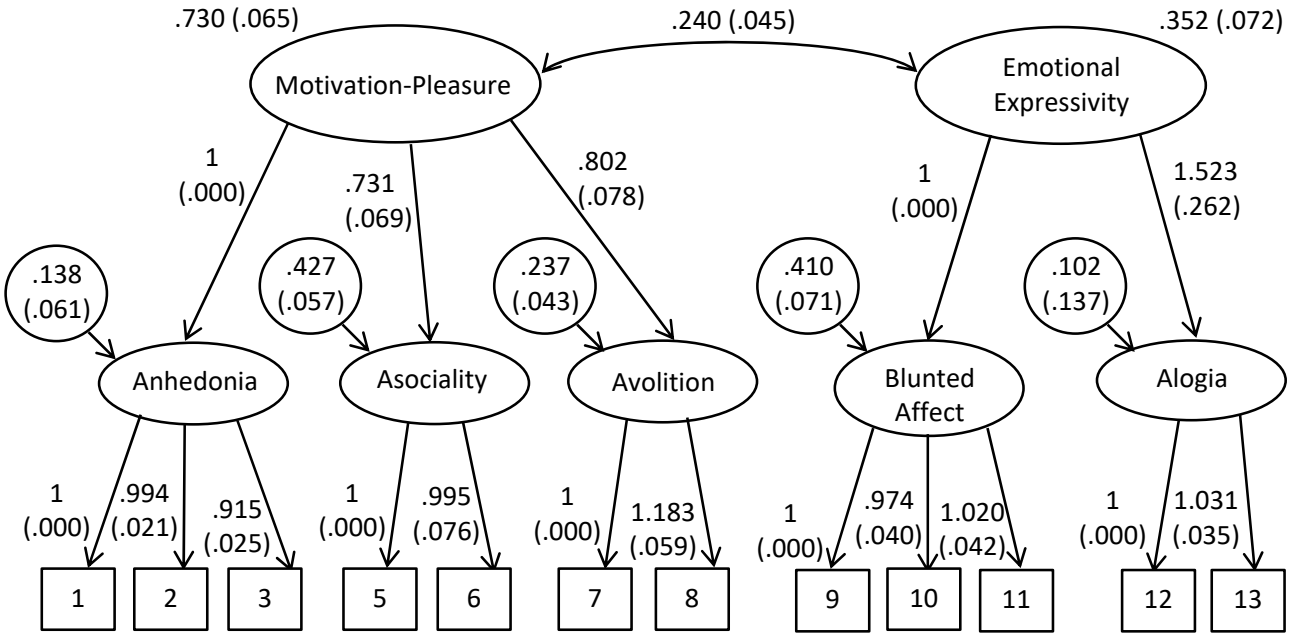
	BNSS Total				BNSS Two-factor				BNSS Five-factor			
Independent Variables	**B**	**SE**	**t**	**p**	**B**	**SE**	**t**	**p**	**B**	**SE**	**t**	**p**
Age (year)	-.065	.076	-.856	.393	-.003	.071	-.045	.965	-.069	.068	-1.017	.310
Sex	.904	.980	.923	.357	.748	.910	.822	.412	1.480	.859	1.723	.086
Education level	**.606**	**.288**	**2.102**	**.037**	.414	.269	1.538	.125	.322	.253	1.273	.204
Duration of illness (year)	-.020	.081	-.253	.800	-.038	.075	-.504	.614	.028	.071	.395	.693
Antipsychotic dose*	-.001	.001	-1.192	.234	-.001	.001	-1.241	.216	-.001	.001	-1.199	.232
PANSS Positive	**-.584**	**.127**	**-4.588**	**<.001**	**-.573**	**.118**	**-4.846**	**<.001**	**-.584**	**.112**	**-5.201**	**<.001**
PANSS Excitement	-.373	.250	-1.493	.137	-.064	.235	-.271	.786	.077	.223	.344	.731
PANSS Depression	**-.427**	**.213**	**-2.007**	**.046**	-.227	.199	-1.144	.254	-.306	.189	-1.618	.107
PANSS Cognition	-.590	.327	-1.806	.072	**-.760**	**.304**	**-2.496**	**.013**	**-.702**	**.292**	**-2.406**	**.017**
BNSS Total	**-.438**	**.044**	**-9.924**	**<.001**								
BNSS MAP					**-.876**	**.078**	**-11.233**	**<.001**				
BNSS EE					-.118	.072	-1.647	.101				
BNSS Anhedonia									.013	.180	.070	.944
BNSS Asociality									**-.950**	**.292**	**-3.256**	**.001**
BNSS Avolition									**-2.503**	**.272**	**-9.217**	**<.001**
BNSS Blunted Affect									-.201	.113	-1.777	.077
BNSS Alogia									.064	.156	.409	.683

BNSS, Brief Negative Symptom Scale; PANSS, Positive and Negative Syndrome Scale; GAF, Global Assessment of Functioning

*Antipsychotic doses were converted into total daily chlorpromazine equivalents

Model summary: For BNSS Total, Adjusted R^2=.444, F(10,263)=22.825, p<.001; For BNSS Two-factor, Adjusted R^2=.521, F(11,262)=27.978, p<.001; For BNSS Five-factor, Adjusted R^2=.581, F(14,259)=28.090, p<.001.

Supplementary Figure 1. Second-order confirmatory factor analysis of the BNSS



Supplementary Table 6. Spearman correlations between BNSS subscales and the consensus PANSS five-factor model (Wallwork et al., 2012)

	BNSS Anhedonia	BNSS Distress	BNSS Asociality	BNSS Avolition	BNSS Blunted Affect	BNSS Alogia	BNSS MAP	BNSS EE	BNSS Total
PANSS Negative	.490**	.354**	.510**	.488**	.700**	.811**	.575**	.847**	.855**
PANSS Positive	.063	-.123*	.170**	.094	.088	.046	.101	.077	.084
PANSS Excitement	.006	-.265**	.157**	.088	-.115	-.005	.067	-.070	-.030
PANSS Depression	.092	-.422**	-.001	.041	-.008	-.136*	.062	-.077	-.053
PANSS Disorganized	.111	.062	.173**	.205**	.213**	.206**	.169**	.247**	.238**

BNSS, Brief Negative Symptom Scale; PANSS, Positive and Negative Syndrome Scale

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Supplementary Table 7. Multiple linear regression with BNSS scores and covariates on GAF, using the consensus PANSS five-factor model (Wallwork et al., 2012)

	BNSS Total				BNSS Two-factor				BNSS Five-factor			
Independent Variables	**B**	**SE**	**t**	**p**	**B**	**SE**	**t**	**p**	**B**	**SE**	**t**	**p**
Age (year)	-.067	.075	-.884	.377	-.001	.070	-.014	.989	-.059	.066	-.882	.379
Sex	.878	.959	.915	.361	.663	.881	.753	.452	1.385	.835	1.659	.098
Education level	.453	.290	1.562	.119	.228	.269	.849	.397	.134	.254	.528	.598
Duration of illness (year)	.014	.080	.170	.865	.0004	.074	.006	.995	.055	.070	.780	.436
Antipsychotic dose*	-.002	.001	-1.516	.131	-.002	.001	-1.599	.111	-.002	.001	-1.606	.109
PANSS Positive	**-.525**	**.129**	**-4.071**	**<.001**	**-.528**	**.118**	**-4.457**	**<.001**	**-.528**	**.113**	**-4.687**	**<.001**
PANSS Excitement	-.338	.208	-1.622	.106	-.061	.194	-.315	.753	.047	.186	.253	.800
PANSS Depression	**-.397**	**.201**	**-1.979**	**.049**	-.142	.186	-.762	.447	-.254	.179	-1.419	.157
PANSS Disorganization/Concrete	**-.784**	**.225**	**-3.479**	**.001**	**-.936**	**.209**	**-4.485**	**<.001**	**-.849**	**.197**	**-4.316**	**<.001**
BNSS Total	**-.441**	**.041**	**-10.690**	**<.001**								
BNSS MAP					**-.910**	**.076**	**-11.997**	**<.001**				
BNSS EE					-.107	.068	-1.574	.117				
BNSS Anhedonia									.007	.175	.037	.970
BNSS Asociality									**-1.165**	**.282**	**-4.126**	**<.001**
BNSS Avolition									**-2.441**	**.266**	**-9.162**	**<.001**
BNSS Blunted Affect									-.152	.111	-1.366	.173
BNSS Alogia									.001	.148	.008	.993

BNSS, Brief Negative Symptom Scale; PANSS, Positive and Negative Syndrome Scale; GAF, Global Assessment of Functioning

*Antipsychotic doses were converted into total daily chlorpromazine equivalents

Model summary: For BNSS Total, Adjusted R^2=.459, F(10,263)=24.117, p<.001; For BNSS Two-factor, Adjusted R^2=.543, F(11,262)=30.510, p<.001; For BNSS Five-factor, Adjusted R^2=.599, F(14,259)=30.104, p<.001.