Psychiatry Research 195 (2012) 39–44

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Self-assessment of psychological stress in schizophrenia: Preliminary evidence of reliability and validity

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ARTICLE INFO

Article history:
Received 11 October 2010
Received in revised form 19 March 2011
Accepted 4 July 2011

Keywords:
Psychotic disorders
Emotions
Affective symptoms
Outcome assessment
Psychometrics

ABSTRACT

Heightened stress sensitivity is a common characteristic of schizophrenia and may be predictive of clinical and functional outcomes. However, systematic assessment is not part of routine clinical practice. This study investigated the reliability and predictive values of two versions of a new scale for the assessment of psychological stress in psychosis (Psychological Stress Index; PSI). Thirty-seven patients with schizophrenia/schizoaffective disorder and 30 healthy controls completed a battery of self-report measures at baseline and 4–8 weeks for test–retest. Thirty-four patients were followed up at 12 months. Both of the 18-item and 9-item PSI demonstrated good levels of reliability and could significantly discriminate patients from healthy controls. Both versions showed moderate convergence with self-report and clinician ratings of depression and anxiety, and superior predictive validity of 12-month follow-up clinical and functional outcomes compared to an existing measure of stress (Perceived Stress Scale). The clinical usefulness of the PSI is supported by its predictive power on cross-sectional and longitudinal outcome. The PSI-9 performed as well as, if not better than, the PSI-18 in this study, but further evaluation is warranted for more conclusive comparison.

1. Introduction

Since the proposal of a diathesis–stress model of psychosis (Rosenthal, 1970), there has been an abundance of research evidence revealing a particular vulnerability to stress in psychotic disorders (Corcoran et al., 2003; Thompson et al., 2004; Phillips et al., 2007; Yuii et al., 2007; Walker et al., 2008). Earlier studies focusing on the relationship between stress and clinical course showed that schizophrenic relapses were often preceded by stressful life events (Birley and Brown, 1970; Ventura et al., 1989, 1992). More recent research data also show that adolescents and young adults at genetic high risk for schizophrenia are more prone to developing psychotic symptoms following upsetting life events (Miller et al., 2001). Evidence of heightened stress sensitivity in schizophrenia also comes from findings of dysregulated biological stress response. Patients with schizophrenia often exhibit higher baseline cortisol levels (see for review Walker and Diforio, 1997), higher post-dexamethasone suppression test (DST) plasma and salivary cortisol levels compared with healthy controls (see for review Tandon et al., 1991, but see Meltzer et al., 2001) and greater adrenocorticotropic hormone and homovanillic-acid responses to a metabolic stress challenge (Brunelin et al., 2007).

Although it is clear that major stressful life events can exacerbate symptoms, recent data suggest that patients do not experience more stressful life events per se; rather, they experience more negative affects to daily life stressors (Docherty, 1996; Horan et al., 2005; Jones and Fernyhough, 2007). Experience sampling studies show that schizophrenia patients report experiencing more intense negative emotions in response to daily stressors than normal controls (Myin-Germeys et al., 2000, 2003). In laboratory tests with evocative emotional stimuli, schizophrenia patients tend to perceive neutral and positive stimuli as more negative, according to a recent meta-analysis (Cohen and Minor, 2010), in agreement with the in vivo work showing that persons with schizophrenia have more negative experiences in their lives. The perception of more negative experiences has an interpersonal counterpart in the family environment. Specifically, stressful interpersonal exchange in patients' homes has been consistently shown in the expressed emotion (EE) literature to worsen symptoms and increase relapse rates (see for review Butzlaff and Hooley, 1998). Lastly, it is worth noting that negative affect in the anticipation of stress is a prominent feature of anxiety syndromes, and clinically significant anxiety is a common feature of schizophrenia (Kendler et al., 1995; Bermanzohn et al., 2000; Pallanti et al., 2004; Voges and Addington, 2005), predicting poor outcome, even after controlling for positive symptoms (Huppert et al., 2001; Pallanti et al., 2004).

Despite the close relationship between vulnerability to stress/negative affect and clinical outcome in psychotic disorders, systematic

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doi:10.1016/j.psychres.2011.07.009

assessments are not part of routine clinical practice. In this study, we investigated the usefulness of a novel self-report scale specifically designed to measure psychological stress in psychosis, the Psychological Stress Index (PSI). The PSI[1] was modeled on the Perceived Stress Scale (PSS; Cohen et al., 1983), which assesses the degree to which one appraises situations in one's life as stressful, focusing on the predictability and controllability of events. Validation studies demonstrate that it predicts physical and mental health outcomes in healthy individuals (Cohen et al., 1983, 1993). For the PSI, items from the PSS were adapted, and new items were generated in an attempt to capture the susceptibility of persons with schizophrenia to experience more negative affect in the face of daily life stressors, particularly those associated with interpersonal interactions, personal responsibilities, social expectations, and novel situations. In addition to the complete 18-item scale (PSI-18), we also examined a shorter version of the PSI (PSI-9), which contains only nine items after removing items that bear a close resemblance to the PSS and negative affect measures and those that result in lower scale reliability. Although the scale focuses on the last month, items tap more trait-like tendencies.

While it is debatable whether patients with schizophrenia are capable of self-assessing emotional states, there is favorable evidence of the reliability and validity of self-report emotional experience by schizophrenia patients in terms of internal consistency (Kring et al., 2003; Tso et al., 2010) and agreement with physiological measures (Hempel et al., 2007). In this study, we examined the psychometric properties of the PSI. Reliability was evaluated using indexes of internal consistency and test–retest reliability. Criterion-related validity was evaluated by the PSI's ability to discriminate patients from healthy controls. Construct validity was evaluated by convergent validity (convergence with negative affect and clinical symptoms) and predictive validity (predictive of functional and clinical outcomes). We hypothesized that the PSI would be moderately correlated with existing self-report and clinician-rated measures of negative affect. Finally, predictive validity was evaluated by the PSI's ability to predict functional (current and 12-month follow-up) and clinical (12-month follow-up) outcomes. These psychometric properties of the PSI were compared against those of the PSS in order to show preliminary evidence of the added value of the PSI.

2. Methods

2.1. Participants

Thirty-seven patients who met the DSM-IV (American Psychiatric Association, 1994) criteria for schizophrenia ($N=27$) or schizoaffective disorder ($N=10$) were recruited from among the outpatients aged between 18 and 60 years, treated in a local community mental health center and a University clinic. Potential participants were identified through chart reviews (approved by the Institutional Review Board of the University of Michigan) and recruited through distribution of flyers to their clinicians. Patients who were unable to give informed consent or on a court-ordered treatment plan were excluded.

Thirty healthy controls were recruited through community advertisements. They were matched to the patients for age, gender, parental education, and family socioeconomic status. Those with lifetime history of mental illness, alcohol or substance abuse/dependence in the past 6 months, history of any serious medical or neurological illness, or history of psychosis in first-degree relatives were excluded.

Diagnoses in patients and absence of Axis-I disorders in controls were established using the Structured Clinical Interview for DSM-IV (SCID; First et al., 1995).

2.2. Measures

2.2.1. Clinician ratings

Patients were assessed for psychotic symptoms using the Brief Psychiatric Rating Scale (BPRS; Overall and Gorham, 1962) and the Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1983). In addition, depressive symptoms were assessed with the 17-item Hamilton Depression Rating Scale (HAM-D; Hamilton, 1960) and the Calgary Depression Scale (CDS; Addington et al., 1992). Functional level was rated using the Global Assessment of Functioning (GAF).

The BPRS positive subscore was calculated by summing the following four items: Hallucinatory Behavior, Unusual Thought Content, Suspiciousness, and Conceptual Disorganization. The BPRS negative subscore was the sum of the following three items: Emotional Withdrawal, Motor Retardation, and Flat Affect. The BPRS depression-anxiety subscore was the sum of the following three items: Depressive Mood, Anxiety, and Guilt Feelings. The SANS score was obtained by summing the global ratings on the domains of Affective Flattening, Alogia, Avolition/Apathy, and Anhedonia/Asociality.

2.2.2. Self-reports

In addition to the PSI, patients also completed the PSS, the Beck Depression Inventory (BDI; Beck et al., 1996), the State Anxiety subscale of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1970), and the Social Adjustment Scale (SAS; Weissman and Staff, 1999). Due to different numbers of items and for easier comparison, PSI and PSS scores shown in this study are scale mean scores (possible range: 0 to 4). The BDI and the STAI were scored according to the conventional scoring scheme (i.e., sum of scale). The overall SAS scores were calculated according to the user manual and then reverse coded, so that higher overall adjustment scores (possible range: 0 to 4) indicate better social adjustment.

2.2.3. Data extraction

Clinical outcomes were indexed by the numbers of interval hospitalizations, days of hospitalization, and psychiatric emergency service visits between baseline and 12-month follow-up.

2.3. Procedure

After written informed consents had been obtained from prospective participants, clinical diagnoses were established using the SCID by a trained master's level clinician (IFT), verified by a senior research psychiatrist (SFT). Participants' educational achievement was estimated using the Wide Range Achievement Test-Reading subtest (WRAT-R; Wilkinson, 1993) and neurocognitive functions using the Brief Assessment of Cognition for Schizophrenia (BACS; Keefe et al., 2004). To assure blindness to patients' self-report scores, clinician ratings (BPRS, SANS, HAM-D, CDS, GAF) were completed before patients were asked to complete the self-report assessments (PSI, PSS, BDI, STAI, SAS).

For the 12-month follow-up, participants were contacted by phone. A brief interview established level of functioning, and the self-report SAS was completed over the phone by a research assistant who was blind to participants' baseline scores.

2.4. Statistical analysis

Demographic, psychological, clinical, and functional measures were compared between the schizophrenia patients (SCZ) and healthy controls (HC) by *t*-test. Reliability of the PSI was examined using Cronbach's alpha (Cronbach, 1951) as an index of internal consistency and concordance correlation coefficient ρ (a more rigorous index of reproducibility than Pearson's *r* correlations; Lin, 1989) as an index of test–retest reliability. Logistic regression was used to examine the ability of the PSI score to discriminate patients from healthy controls to establish criterion-related validity. Convergent validity was examined by correlating the PSI with an existing stress scale (PSS), self-report negative affect (BDI, STAI) and clinician-rated negative affect (HAM-D, CDS, and BPRS depression-anxiety) using Pearson's *r*. Relationships between the PSI and clinical symptoms (BPRS positive, BPRS negative, SANS, and BPRS total) were also examined using Pearson's *r*. Predictive validity was evaluated by a) correlations with functional outcome measures (current and 12-month SAS and GAF) using Pearson's *r*; b) correlations with 12-month clinical outcomes (interval number of hospitalizations, days of hospitalizations, and psychiatric emergency visits) using Spearman's rho, a robust correlation index for linear as well as monotonous non-linear relationships—likely to be the case of these clinical outcome measures (i.e., zero frequency for most participants but multiple incidents for some participants); and c) regression analyses using a model comparison approach to test if the PSI explained further variance of 12-month functional outcome after controlling for baseline functioning.

3. Results

3.1. Participant characteristics

Demographic and clinical characteristics of the participants are summarized in Table 1. Thirty-three schizophrenia patients and 29 controls could be re-contacted within 4–8 weeks after initial assessment for test–retest reliability; four patients and one control could not complete test–retest due to scheduling difficulty. Thirty-four patients could be followed up at 12 months, and two patients were unavailable for contact and one declined participation. Scores on the measures of psychological stress, negative affect, and clinical/-functional outcome are displayed in Table 2. The SCZ and HC groups were well matched for age, sex, parental education and family socioeconomic status. As expected, SCZ had significantly less

[1] See Supplementary Material for PSI items and scoring scheme.

Table 1
Participant demographic and clinical characteristics.

	Schizophrenia/ schizoaffective	Healthy controls	t or χ^2
	Mean (S.D.)	Mean (S.D.)	
Demographics			
Age	42.0 (10.0)	41.8 (11.6)	0.10
Sex (m/f)	20/17	17/13	0.05
Education, years	14.0 (2.5)	16.3 (2.2)	−4.03***
Parental education, years	15.8 (3.6)	15.4 (2.7)	0.48
Socio-economic status	2.6 (0.8)	2.4 (0.6)	1.10
Cognitive measures			
WRAT-R	48.5 (6.9)	51.7 (3.6)	−2.29*
BACS	−1.88 (1.22)	0 (1.0)	−6.74***
Clinical measures			
Age of onset	18.8 (6.8)	–	–
Duration of illness	23.2 (11.3)	–	–
# Hospitalizations	8.2 (11.1)	–	–
CPZeq (mg daily)	536 (558)	–	–
BPRS positive	10.7 (3.4)	–	–
BPRS negative	9.0 (2.3)	–	–
BPRS depression-anxiety	6.9 (3.0)	–	–
BPRS total	38.1 (6.9)	–	–
SANS	9.3 (3.1)	–	–
HAM-D	4.5 (4.4)	–	–
CDS	2.1 (3.1)	–	–
Antidepressant (y/n)	11/26	–	–
Mood stabilizer (y/n)	8/29	–	–
Anxiolytic (y/n)	6/31	–	–

*** $P<0.001$.
* $P<0.05$.

education, poorer neurocognition (BACS) and reading level (WRAT-R), and lower GAF and SAS scores than HC. SCZ also showed elevated psychological stress and negative affect, as suggested by their significantly higher PSI-18, PSI-9, PSS, BDI, and STAI scores compared to HC.

3.2. Psychometric properties of the PSI

3.2.1. Reliability

Both versions of the PSI exhibited good levels of internal consistency in SCZ (PSI-18: $\alpha=0.88$; PSI-9: $\alpha=0.86$) and HC (PSI-18: $\alpha=0.89$; PSI-9: $\alpha=0.82$). They showed satisfactory test–retest reliability in SCZ (PSI-18: $\rho=0.77$; PSI-9: $\rho=0.66$) and high stability in HC (PSI-18: $\rho=0.82$; PSI-9: $\rho=0.88$). See also Table 2 for reliability indexes of other self-report measures.

3.2.2. Criterion-related validity

As mentioned above, SCZ scored significantly higher on both versions of the PSI than HC (Fig. 1). As suggested by the results of logistic regression analyses, SCZ/HC could be classified based on PSI-18 score at an overall accuracy of 83.6% ($\beta=-3.19$, s.e.(β) = 0.74, Wald's $\chi^2=18.37$, exp(β) = 0.041, $P<0.001$) or based on PSI-9 score at an overall accuracy of 82.1% ($\beta=-2.41$, s.e.(β) = 0.57, Wald's $\chi^2=17.63$, exp(β) = 0.09, $P<0.001$).

3.2.3. Construct validity

3.2.3.1. Convergence validity. Table 3 summarizes the correlations between the measures of stress, negative affect, and clinical symptoms among the SCZ group. Both versions of the PSI were highly correlated with the PSS. The PSI correlated moderately to highly with self-report and clinician-rated negative affect. While the PSI-18 showed similar magnitudes of correlations with negative affect (r ranged from 0.56 to 0.74) as the PSS did (r ranged from 0.57 to 0.75), the PSI-9 showed somewhat lower correlations (r ranged from 0.52 to 0.65). Despite the similarities between the PSI and PSS in terms of correlations with negative affect, the two instruments showed distinct symptom correlates. The PSI was inversely correlated with negative symptoms (BPRS negative, SANS), whereas the PSS was associated with more total symptomatology (BPRS total).

3.2.3.2. Predictive validity. Table 4 summarizes the correlations between the PSI and functional and clinical outcome measures for SCZ patients. Both of the versions of the PSI were moderately correlated with current and 12-month prospective SAS. However, no significant correlations with current and 12-month GAF were found. Functional correlates of the PSI were similar to those of the PSS. As for clinical outcomes, the PSI-18 significantly predicted the number of 12-month interval hospitalizations and the PSI-9 significantly predicted all four clinical outcome measures: presence of interval hospitalization, number of hospitalizations, days of hospitalizations, and number of psychiatric emergency visits. The PSS did not significantly predict clinical outcomes.

Regression analyses were performed to further test the predictability of 12-month SAS by the PSI and PSS in SCZ (see Table 5). Model

Table 2
Descriptive statistics of stress sensitivity, negative affect, clinical and functional outcome measures.

	Scale range	Schizophrenia ($N=37$)			Controls ($N=30$)			t
		Mean (S.D.)	α	ρ	Mean (S.D.)	α	ρ	
Stress/negative affect								
PSI-18	0–4	2.16 (0.64)	0.88	0.77	1.13 (0.50)	0.89	0.82	7.19***
PSI-9	0–4	2.18 (0.69)	0.86	0.66	0.97 (0.54)	0.82	0.88	6.54***
PSS	0–4	1.99 (0.83)	0.89	0.77	1.03 (0.66)	0.90	0.55	5.12***
BDI	0–63	14.8 (12.4)	0.93	0.74	2.9 (4.7)	0.88	0.65	5.38***
STAI	20–80	45.6 (12.6)	0.92	0.63	27.8 (7.2)	0.90	0.67	7.19***
Functioning								
GAF	0–100	45.5 (5.5)	–	–	77.8 (21.8)	–	–	−7.89***
SAS	0–4	2.7 (0.69)	–	–	3.5 (0.25)	–	–	−6.22***
12-month GAF[a]	0–100	45.9 (6.6)	–	–	–	–	–	–
12-month SAS[a]	0–4	2.7 (0.56)	–	–	–	–	–	–
12-month clinical outcomes								
Hospitalization (y/n)[b]	–	7/30	–	–	–	–	–	–
Hospitalization (#)[b]	–	0.3 (0.8)	–	–	–	–	–	–
Hospitalization (days)[b]		1.1 (3.6)						
Psychiatric emergency visits[b]	–	0.4 (1.1)	–	–	–	–	–	–

α: Internal consistency as indexed by Cronbach's alpha.
ρ: 4–8 weeks test–retest reliability as indexed by concordance correlation.
*** $P<0.001$.
[a] Only 34 schizophrenia patients could be assessed at 12 months.
[b] Data extracted from patient records for all 37 schizophrenia patients.

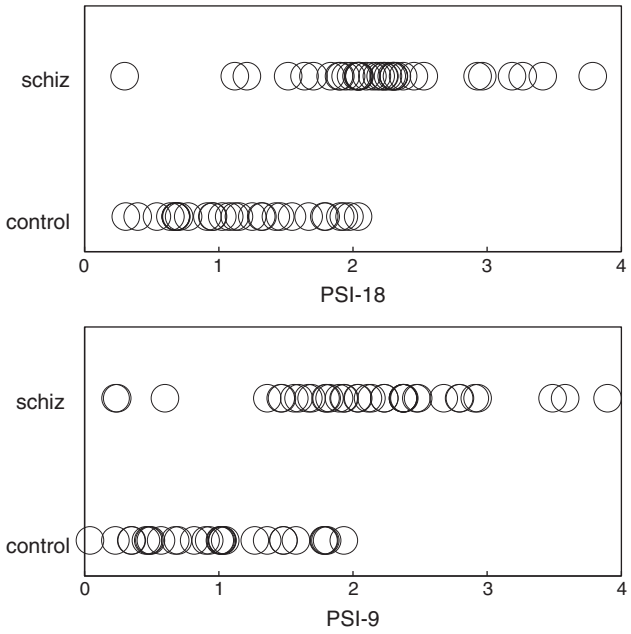

Fig. 1. PSI-18 (upper panel) and PSI-9 (lower panel) scores by group. Data points are jittered by a random value up to ±0.05 to minimize overlap for display purpose.

1 examined additional variance explained by each of the stress measures after controlling for baseline SAS. As expected, baseline SAS significantly predicted 12-month SAS (Reduced Model 1). Both PSI-18 (Full Model 1A) and PSI-9 (Full Model 1B) explained significantly more variance of 12-month SAS in addition to baseline SAS, whereas PSS did not (Full Model 1C). PSI's predictive value was further evaluated by controlling for PSS using this model comparison approach. PSS significantly predicted 12-month SAS (Reduced Model 2). PSI-18 (Full Model 2A) and PSI-9 (Full Model 2B) explained significantly more variance of 12-month SAS in addition to PSS. The regression analysis procedure was repeated for GAF, but neither PSI nor PSS was a significant predictor of 12-month GAF after controlling for baseline GAF.

4. Discussion

The psychometric properties of the Psychological Stress Index provide preliminary evidence that it is a reliable and valid scale of self-report psychological stress in patients with schizophrenia. Reliability indices of the PSI were comparable among schizophrenia patients and healthy controls, indicating that patients endorsed items in a consistent way and their responses were relatively stable over time. Patients scored significantly higher on the PSI than controls, and the PSI score classified patients/controls with over 80% accuracy. Together with the finding of high level of convergence with the existing Perceived Stress Scale (PSS) and moderate convergence with self- as well as clinician ratings of negative affect, the PSI appears to be measuring a construct that may be appropriately labeled as psychological stress.

The clinical utility of the PSI is supported by its ability predict current and long-term social functioning for patients with schizophrenia. After controlling for baseline SAS, the PSI remained a significant predictor of 12-month SAS. This ruled out the possibility that the PSI predicted long-term SAS merely because it contains several social interaction-related items that potentially overlap with what the SAS measures. More importantly, this finding suggests that the PSI captures something that significantly contributes to *change* in social functioning in the long run for schizophrenia patients. Together with the finding that the PSI accounted for significantly more variance of 12-month SAS in addition to PSS, the PSI appears to measure not only general perceived stress but psychological stress that may be specific in schizophrenia.

The pathway from heightened psychological stress to poorer social outcome in schizophrenia remains to be elucidated, but it is likely to involve negative affect. We found in this study that stress was moderately correlated with negative affect, consistent with the associations found between cortisol dysregulation and affective symptoms (Ismail et al., 1998; Ritsner et al., 2004). Elevated negative affect in schizophrenia has been found to be related to lower quality of life and more suicide attempts, even after controlling for positive and negative symptoms (Huppert et al., 2001; Pallanti et al., 2004; Narvaez et al., 2008). We have also found in a cross-sectional study that negative affect is an important determinant of social functioning in schizophrenia (Tso et al., 2010). Taken together, these findings suggest heightened psychological stress may contribute to current and prospective social functioning in schizophrenia through negative affect. Future studies are needed to further elucidate if heightened psychological stress as measured with the PSI corresponds to heightened stress reactivity as measured with experimental and experience sampling methods in schizophrenia.

Our measure of psychological stress did not show significant relationships with psychotic symptoms. While it is clear from the literature that high levels of stress (e.g., major life events, trauma, stressful familial environment) are linked to the development and exacerbation of psychotic symptoms (Birley and Brown, 1970; Ventura et al., 1989, 1992), the chronicity and relative stability of the patients in this study may have eliminated this relationship. While the patients showed more perceived stress to daily life activities/stressors than healthy individuals, it did not appear to drive positive symptoms. As all of the patients were on stable doses of antipsychotics, it is not too surprising that without significant variance in positive symptoms, a relationship would not be observed in the data.

On the other hand, psychological stress as measured with the PSI was inversely correlated with negative symptoms. Although somewhat counter-intuitive, other investigators have indeed reported an association between more negative symptoms and less negative affect. Communication deficits were elicited in non-deficit syndrome patients describing negative, stressful memories, but not in patients with enduring, deficit negative symptoms (Docherty et al., 1994; Docherty and Hebert, 1997; Burbridge and Barch, 2002; Cohen and

Table 3
Pearson correlations between measures of stress, negative affect, and symptomatology among schizophrenia patients at baseline.

	Stress			Self-report negative affect		Clinician-rated negative affect			Symptomatology			
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. PSS				0.75***	0.70***	0.66***	0.64***	0.57***	0.16	−0.06	−0.11	0.40*
2. PSI-18	0.80***			0.74***	0.64***	0.65***	0.56***	0.57***	0.06	−0.30†	−0.31†	0.14
3. PSI-9	0.76***	0.94***		0.65***	0.52***	0.62***	0.57***	0.61***	0.11	−0.31†	−0.34*	0.20

4: Beck Depression Inventory (BDI); 5: Spielberger State Anxiety Inventory (STAI); 6: Calgary Depression Scale (CDS); 7. Hamilton Depression Rating Scale (HAM-D); 8: Brief Psychiatric Rating Scale (BPRS) anxiety-depression; 9: BPRS positive; 10: BPRS negative; 11: Scale for the Assessment of Negative Symptoms (SANS); 12: BPRS total score.

*** $P<0.001$.

* $P<0.05$.

† $P<0.10$.

Table 4
Correlations between psychological stress and outcome measures among schizophrenia patients.

	Current functioning (Pearson's r) ($N=37$)		12-month functional outcome (Pearson's r) ($N=34$)		12-month clinical outcome (Spearman's ϕ) ($N=37$)			
	SAS	GAF	SAS	GAF	Hosp (yes/no)	# Hosp	# Days hosp	Psych ER visits
PSS	−0.66***	−0.16	−0.60***	−0.16	0.26	0.28†	0.28	0.29†
PSI-18	−0.59***	0.07	−0.67***	−0.07	0.32†	0.34*	0.31†	0.24
PSI-9	−0.54***	0.06	−0.68***	−0.06	0.51**	0.51**	0.45*	0.33*

*** $P<0.001$.
** $P<0.01$.
* $P<0.05$.
† $P<0.10$.

Docherty, 2004a). One can speculate that this inverse relationship between psychological stress response and negative symptoms might reflect an emotional buffering effect of negative symptoms. Interview-based and self-report studies of negative emotions generally show less negative emotions in negative/deficit syndrome (Kirkpatrick et al., 1993, 1994; Cohen and Docherty, 2004b; Heerey and Gold, 2007) and two laboratory studies (Cohen et al., 2003; Fahim et al., 2005) support this finding (but see also Berenbaum and Oltmanns, 1992; Earnst and Kring, 1999). The reaction to stimuli is an important part of the subjective stress response, and with less intrinsic drive and motivation, negative-syndrome patients may not engage in situations that would lead to a stressful interaction. The complex relationships between stress sensitivity, emotional experience, emotional expression and volition are only recently being mapped out in schizophrenia (see Barch, 2005; Horan et al., 2008), so much work will be needed, for example, advanced statistical techniques such as structural equation modeling, before one can confirm or reject this speculation.

Several caveats should be kept in mind. This study was limited by a relatively small sample size. As mentioned, the patients studied were stable outpatients in a community mental health center, and the reliability of self-report may not hold in acutely ill or hospitalized psychotic patients. While the results have value, larger samples would enable examinations of the factor structure of the PSI, the interactive effect between neurocognition and psychological stress on functional outcome (Myin-Germeys et al., 2002), and more complex models linking all the psychological, behavioral, clinical, and outcome variables. It should also be noted that the PSI did not predict GAF. This may be due to the nature of GAF, which measures both symptom severity and level of social functioning (see also Tso et al., 2010). Schizophrenia patients had a narrower spread of GAF scores, partly due to their severe symptoms, thus limiting the ability of GAF to detect meaningful variations in the functional outcome in our chronic schizophrenia sample. In future studies, symptom severity should be isolated from clinician-rated functional outcome measures to provide further evidence of the predictive validity of the PSI.

To conclude, this study demonstrated that the PSI is a reliable and valid measure of psychological stress in schizophrenia. Its predictive power on cross-sectional and long-term functional and clinical outcome supports the value of integrating self-assessments of stress in clinical and research practice. We recommend the use of the PSI-9 as it is briefer and showed better performance in predicting long-term outcomes in this study compared to the PSI-18, but further studies are needed for more conclusive comparisons between the two versions.

Table 5
Comparison of regression models using PSS, PSI-18, and PSI-9 as predictors of 12-month SAS in 34 schizophrenia patients.

Predictor variable	Variable statistics			Model statistics			
	β[a]	t	P	r^2	Δr^2	ΔF	P
Reduced Model 1							
Baseline SAS	0.71	5.68	<0.0001	0.502	0.502	32.27	<0.0001
Full Model 1A							
Baseline SAS	0.48	2.90	0.007				
PSI-18	−0.34	−2.05	0.049	0.562	0.060	4.21	0.049
Full Model 1B							
Baseline SAS	0.46	3.13	0.004				
PSI-9	−0.39	−2.67	0.012	0.595	0.093	7.13	0.012
Full Model 1C							
Baseline SAS	0.57	3.32	0.002				
PSS	−0.20	1.18	0.248	0.523	0.021	1.38	0.248
Reduced Model 2							
PSS	−0.60	−4.19	<0.0001	0.354	0.354	17.56	<0.0001
Full Model 2A							
PSS	−0.13	−0.53	0.602				
PSI-18	−0.56	−2.29	0.029	0.448	0.094	5.25	0.029
Full Model 2B							
PSS	−0.12	−0.55	0.587				
PSI-9	−0.59	−2.64	0.013	0.473	0.118	6.96	0.013

[a] Standardized beta coefficient.

Acknowledgments

Funding of this study was provided by the Palencsar Schizophrenia Research Fund [to S.F.T.] and the National Institute of Mental Health [R01-MH64148 to S.F.T.].

Appendix A. Supplementary data

Supplementary data to this article can be found online at doi:10.1016/j.psychres.2011.07.009.

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