Validity and reliability of the Vigour Assessment Scale in avolitional schizophrenia outpatients

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Abstract

A few items of existing schizophrenia scales measure avolition, but no research has been reported on vigour in schizophrenia, including whether avolition would be more or less the inverse of vigour. Such research requires a valid and reliable measure of vigour. In the absence of this, this study developed and examined the validity and the reliability of the Vigour Assessment Scale (VAS) among 242 avolitional schizophrenia outpatients in relation to measures of workplace vigour, behavioral inhibition and activation, procrastination, fatigue, anxiety, depressive features, and active involvement in personal growth. Convergent validity was found in moderate to strong correlations (r = 0.5 to 0.714) between the VAS and measures approximate to vigour. Discriminant validity was found in lower and/or inverse correlations with depression (r = -0.423), anxiety (r = -0.279), behaviour inhibition (r = -0.045), procrastination (r = -0.656), and fatigue (r = -0.684). Internal consistency was good with Cronbach's alpha coefficients above 0.8, and strong correlations for split-half (r = 0.71) and test-retest (r = 0.77) reliability. The standard error of measurement was seven on a scale of 145 points. An exploratory factor analysis yielded a 27-item version with a six-factor structure accounting for 61.9% of the cumulative variance. These results suggest that the VAS is a valid and reliable instrument in avolitional schizophrenia outpatients, suitable for use in further research on vigour and when vigour is pursued therapeutically or in efficacy studies. Subject to further validation, the VAS may be used in other clinical populations (e.g., in depression) and healthy populations where vigour may be pursued as a desirable attribute.

Keywords

Vigour
Avolition
Negative symptoms
Psychometry
Assessment

1. Introduction

While vigour may generally seem like an appealing and virtuous attribute to which one may aspire, for some people living with schizophrenia, the lack thereof is a persistent impediment to functioning. The lack of vigour has been captured in various symptomatological terms including avolition, anergia, inertia, amotivation and difficulties with effort, persistence and energy (Rector et al., 2005; Richard et al., 2013; Treadway et al., 2015; Marder and Galderisi, 2017). Avolition in schizophrenia is described as a reduction in the motivation to initiate or persist in goal-directed behaviour (Barch and Dowd, 2010). It has been considered among the most disabling deficits in schizophrenia that persist after acute phases and consistently predict poor psychosocial outcomes (Foussias et al., 2009; Marder and Galderisi, 2017).

Vigour has been considered the antithesis to burnout and exhaustion (Shirom, 2011) and may be taken as the positive inverse, at least in part, of avolition. Examining vigour extends existing research in schizophrenia on avolition in the terms of positive psychiatry (Eglit et al., 2018), invoking conceptual connotations with resilience (Clinton et al., 2017), vitality (Ryan and Frederick, 1997), thriving (Spreitzer et al., 2005), and engagement (Shirom, 2011). Research on vigour in schizophrenia prompts a positive line of enquiry where the principal focus is not on alleviating the negative and that which is absent, but rather on building upon the positive and strengthening inner resources and that which is present (Bellack, 2006; Eglit et al., 2018; Nguyen and Jeste, 2019).

While avolition in schizophrenia has been examined, especially in relation to negative symptoms (Marder and Galderisi, 2017; Eglit et al., 2018), a paucity of research on vigour in schizophrenia may be attributed to the absence of a suitable measuring instrument. Outside psychiatry, a single instrument is used to measure vigour, i.e. the Shirom-Melamed Vigour Measure (SMVM) (Shirom, 2003) but it is confined to occupational vigour. Closest to measuring vigour in schizophrenia are a few items of existing schizophrenia scales that measure an inverse approximation of vigour. These are items on avolition contained in the Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1983), the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987), the Clinical Assessment Interview for Negative Symptoms (CAINS) (Horan et al., 2011), and the Schedule for the Deficit Syndrome (SDS) (Kirkpatrick et al., 1989).

In response, this study developed and examined the validity and the reliability of the Vigour Assessment Scale (VAS) in avolitional schizophrenia outpatients in a residual phase. Validity of the VAS was examined for its convergence with existing instruments measuring constructs approximate to vigour, and its discriminant ability to discern vigour from dissimilar constructs including procrastination, behavioral inhibition, fatigue, anxiety, and depression. Reliability was examined by its internal consistency, split-half reliability, test-retest reliability and standard error of measurement.

2. Materials and methods

2.1. Participants

Participants were outpatients with residual avolitional schizophrenia recruited and conveniently sampled from a psychiatric hospital in Pretoria, South Africa. For inclusion, participants needed to be at least 18 years of age and diagnosed with residual avolitional schizophrenia as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). The residual phase was defined accordingly as "manifested by only negative symptoms or by two or more symptoms listed in Criterion A present in an attenuated form", thus excluding the potential confounding effects of acute phase symptoms. Avolition was defined on the Positive and Negative Syndrome Scale (PANSS), requiring a rating of 3 or more on item G13 (disturbance of volition) and a minimum score of 10 for the sum of items G13, N4 (passive/apathetic social withdrawal) and N2 (emotional withdrawal) (Kay et al., 1987). The G13 item labelled "disturbance of volition" and described as a "disturbance in the wilful initiation, sustenance, and control of one's thoughts, behaviour, movements and speech" was not taken as an adequate criterion for avolition considering this item's overlap with ambivalence and the results of a two factor model in which it clustered both with expressive deficits (reflecting a loss of initiative), as well as the second factor reflecting social amotivation (but with a lower loading) (Liemburg et al., 2013). Instead, a composite inclusive criterion was adopted as to ensure that participants would be avolitional even when overlapping with other negative symptoms. To ensure that ratings on these items were adequately informed, an interview and observation guide (see Supplementary material) was applied in addition to obtaining information from clinical records, nursing personnel, and family. Participants were further required to be in a stable condition as indicated by unaltered medication dosages during the preceding three months, as self-reported and recorded in the clinical notes.

Participants were excluded if they were in an acute phase of schizophrenia as defined by DSM-5, diagnosed with a prominent comorbid psychiatric disorder, and if a positive substance history during the preceding three months was self-reported or noted in the clinical records. Further exclusion criteria were the presence of unstable or significant medical disorders, a past head injury with neurological sequelae or causing loss of consciousness, and intellectual disability.

2.2. The Vigour Assessment Scale (VAS)

The Vigour Assessment Scale (VAS) is a new self-report instrument comprising 48 items, formulated to measure vigour with both positive (being present) and negative (being absent) items. Items' content validity was derived from a conceptual exploration of the concept of vigour by considering related concepts and its experiential and behavioral manifestations when present and absent respectively, and capturing these inclusively by formulating candidate items even if some were overlapping. Candidate items were then supplemented by adapting selected items from proximate instruments (see below), tailoring the content appropriately to the concept of vigour. Repetitive items were then removed, ensuring that each remaining item captured a specific nuance of vigour. Items were then standardised in format and piloted among two patients from the same population for their

understandability. Each item is rated on a four-point Likert scale according to the frequency of the experience during the preceding seven days (1 = None of the time, 2 = Sometimes, 3 = Often, 4 = Most of the time). The total score is calculated by subtracting the subtotal of Category A (absence of vigour) from the subtotal of Category B (presence of vigour). The total score can theoretically range between a minimum of -51 and a maximum of 74. To prevent acquiescence bias, the positive and negative items are interspersed on the response sheet.

2.3. Other instruments

The SMVM was included as it is the only instrument designed to measure vigour, although it is confined to measuring occupational vigour in a non-clinical population (Shirom, 2003). It comprises 12 items that are self-reported on a seven-point Likert scale, with three subscales addressing physical strength, emotional energy and cognitive liveliness. Its internal consistency, as indicated by Cronbach's alpha calculations, was reported as 0.951 for physical strength, 0.883 for cognitive liveliness and 0.937 for emotional energy, with an overall value of 0.948 (Derman, 2008).

The Personal Growth and Initiative Scale (PGIS) measures an individual's active involvement and developing as a person. Its 16-item version comprises four subscales, namely readiness for change (RC), planfulness (Plan), using resources (UR), and intentional behaviour (IB). Its first-order four-factor structure demonstrated adequate goodness-of-fit indices. Test-retest reliability indices were adequate, ranging from 0.73 (UR) to 0.81 (Plan), as was internal consistency (RC, $\alpha = 0.83$; Plan, $\alpha = 0.84$; UR, $\alpha = 0.80$; IB, $\alpha = 0.89$) (Robitschek et al., 2012).

The Behavioral Inhibition/Behavioral Activation Scales (BIS/BAS) comprise 24 items in a Likert-type format that measure an individual's sensitivity to two motivational systems, captured by four subscales (Carver and White, 1994). Behaviour inhibition is captured by one subscale, which includes all items describing reactions to the anticipation of punishment, non-reward and novelty. In the remaining three subscales, behaviour activation refers to drive, fun-seeking, and reward responsiveness. In a sample of 732 college students, the factors cumulatively accounted for 49% of the overall variance. Cronbach's alpha values ranged between 0.66 and 0.76 for each factor (BIS, $\alpha = 0.74$, Reward Responsiveness, $\alpha = 0.73$, Drive, $\alpha = 0.76$ and Fun Seeking, $\alpha = 0.66$). Test-retest reliability in 113 subjects after eight weeks was found to have correlation coefficients of moderate strength (0.66 for BIS, 0.66 for Drive, 0.59 for Reward Responsiveness, and 0.69 for Fun Seeking). Individual with schizophrenia showed higher BIS sensitivity and no differences in BAS sensitivity than healthy controls (Barch and Dowd, 2010; Horan et al., 2011; Strauss et al., 2011). In a study on approach and avoidance tendencies among 151 individuals with schizophrenia, significant patterns of sensitivity to behavioral inhibition and activation were found (Reddy et al., 2014).

The Procrastination Scale (Proc Scale) (Yockey and Kralowec, 2015) was used in light of the expectation that procrastination would be related inversely to vigour. It is a 20-item true-false measure on a Likert scale ranging from 1 to 5. A two-factor structure was found with various descriptions, including a Tendency to Postpone Tasks and Getting Tasks Done on Time (Mariani and Ferrari, 2012), Delay and Procrastination factors (Argiropoulou and

Ferrari, 2015), and Frequency of Procrastination and Reasons for Procrastination factors (Yockey and Kralowec, 2015). A recent study identified a five-component structure of the instrument, namely good planning, delaying, doing things in the last minute, well time management and poor time management (Hasanagic and Ozsagir, 2018). Lay (1986) reported a Cronbach's alpha of 0.82 for the instrument. Ferrari (1989) found its test-retest reliability as correlating strongly (r = 0.8), and Hasanagic and Ozsagir (2018) reported a Cronbach's alpha of 0.71.

The Fatigue Assessment Scale (FAS) (Shahid et al., 2012) is a 10-item scale using a five-point Likert scale ranging from 'never' to 'always'. Although not specifically designed for schizophrenia, it has been reported to be a valid and reliable scale among various other populations, including construction workers, women with breast problems and mothers of infants and young children (De Vries et al., 2010; Dunning and Giallo, 2012; Zhang et al., 2015). Its one-factor structure explained between 53% and 67% of the variance. Internal consistency was good, with alpha ratings between 0.88 and 0.90, as was test-retest reliability at a one-month interval (r = 0.88). Pearson correlations between the FAS and subscales of the other fatigue questionnaires ranged between 0.61 and 0.78 (Michielsen et al., 2003). Discriminant validity testing was demonstrated when compared to depressive symptoms, neuroticism and state anxiety (De Vries et al., 2010).

The Calgary Depression Scale for Schizophrenia (CDSS) is a clinician-rated instrument comprising nine items with descriptive anchor points. Correlation coefficients with other measures of depression ranged between 0.8 and 0.9 (Addington, Addington et al., 1990, Addington, Addington et al., 1992, Addington, Addington et al., 1994). It accurately distinguishes depressive features from negative symptoms and extrapyramidal side effects (Addington, Addington et al., 1996). Cronbach's alpha coefficients between 0.7 and 0.9 were reported (Addington, Addington et al., 1990).

The Staden Schizophrenia Anxiety Rating Scale (S-SARS) is a clinician-rated instrument for the assessment of specific and general anxiety symptoms in schizophrenia (Naidu et al., 2014). The specific anxiety subscale measures persecutory and nihilistic anxiety, perceptual anxiety, anxiety attacks, situational anxiety and obsessive-compulsive anxiety. The general anxiety subscale measures somatic anxiety, psychomotor and cognitive agitation, worry and fear, control-related anxiety and impairment from anxiety. The interview guide of the S-SARS informs the ratings, each with six narrative anchor points to indicate severity. A Cronbach's alpha coefficient of 0.88 was reported (Naidu et al., 2020).

2.4. Procedures and ethics approval

Willing participants and their clinical records were assessed for meeting the inclusion and exclusion criteria. The interview-based measures (the three PANSS items, the CDSS, and the S-SARS) were administered by one of us suitably trained in their use. Thereafter, participants completed in fixed order the VAS, the other self-rating scales, and repeated the VAS no less than an hour after doing it the first time. The authenticity of responses was supervised during the completion of the self-rating scales and participants were advised to take short breaks if they became fatigued. Written informed consent to participate in the study was obtained from each participant. The study was performed in accordance with the

2013-version of the Declaration of Helsinki, and ethics approval was obtained from the legally accredited Faculty of Health Sciences Research Ethics Committee of the University of Pretoria.

2.5. Statistical analyses

For convergent and discriminant validity, parametric correlations (Pearson's) were examined among the measures. For examining the reliability of the VAS, Cronbach's alpha coefficients, Spearman-Brown coefficients, Spearman-Brown and Guttman split-half coefficients, and the Standard Error of Measurement (SEM) (as the product of the standard deviation and the square root of one minus the reliability coefficient) were calculated. Internal consistency was measured for the VAS in a sequential item deletion analysis and for the positive and the negative item categories. For test-retest reliability, Pearson's correlation coefficients were calculated. An Exploratory Factor Analysis (EFA) was performed to identify the underlying factor structure of the VAS.

3. Results

3.1. Descriptive features

Age, gender and educational characteristics of the 242 participants are presented in Table 1. Table 2 presents the mean scores with 95% confidence intervals for the various instruments. The VAS scores ranged from -51 to 74 within the theoretical minimum and maximum range from -67 to 77, with a mean of 12.02 (8.81–15.24 95%CI). A normal distribution was assumed based on the distribution of data shown in Fig. 1, Fig. 2 that approximated a normal pattern, and by virtue of a Shapiro-Wilk test value of 0.99 (p = 0.44) and a **Kolmogorov-Smirnov test value of 0.04 (p > 0.15).**

Table 1. Descriptive characteristics of the sample (n = 242).

		Frequency	Percent (%)
Gender	**Male**	176	72.7
	Female	66	27.3
Highest level of education	**Grade 8**	15	6.2
	Grade 10	95	39.3
	Grade 12	93	38.4
	University graduate	39	16.1
			95% confidence interval
Age	**Mean**	37.4	36.0 to 38.7

Table 2. Descriptive statistics for the VAS and existing instruments (n = 242).

Instrument	Mean (SD)	95% CI	
Vigour Assessment Scale (VAS)	12.02 (25.42)	8.81	15.24
Avolitional items of the Positive and Negative Symptom Scale (G13, N2, N4 on PANSS)	13.76 (3.01)	13.38	14.14
Shirom-Melamed Vigour Measure (SMVM)	51.20 (16.77)	49.07	53.31
Personal Growth and Initiative Scale-II (PGIS - II)	39.59 (13.66)	37.86	41.32
Behaviour Inhibition/Behaviour Activation Scale (BIS/BAS)			
Behaviour inhibition	19.82 (4.38)	19.19	20.37
Drive	11.24 (3.16)	10.84	11.61
Reward-responsiveness	16.14 (3.24)	15.17	16.54
Fun-seeking	10.78 (2.92)	10.39	11.15
Procrastination Scale (Proc Scale)	56.64 (12.17)	55.1	58.2
Fatigue Assessment Scale (FAS)	24.96 (8.70)	23.86	26.06
Staden Schizophrenia Anxiety Rating Scale (S-SARS)	2.26 (4.67)	1.66	2.85
Calgary Depressive Symptoms Scale (CDSS)	1.33 (2.78)	0.98	1.69

SD = Standard deviation; CI = confidence interval.

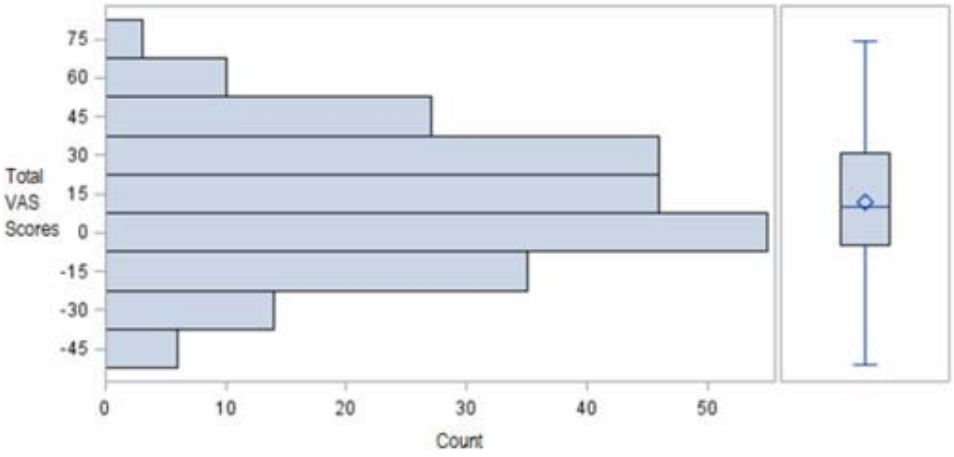

Fig. 1. Distribution plot for the VAS.

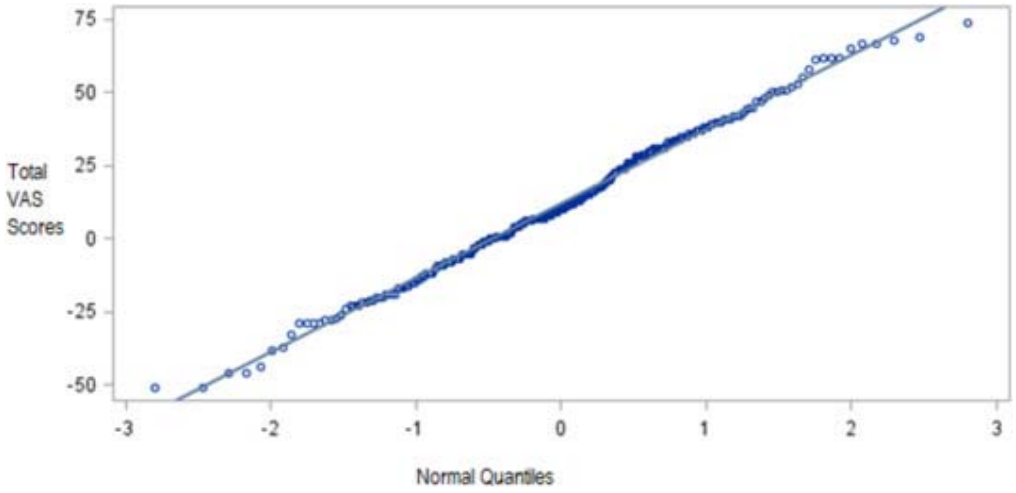

***Fig. 2**. Probability plot for the VAS.*

3.2. Convergent and discriminant validity

For convergent validity testing, Table 3, Table 4 show correlations of a moderate to strong degree of the VAS with the SMVM and the PGIS and their subscales, as well as the drive, reward-responsiveness and fun-seeking subscales of the BISBAS. A positive correlation with the SMVM was the strongest. For discriminant validity, the VAS correlated weakly and/or negatively with behavioral inhibition on the BISBAS, FAS, Proc Scale, S-SARS and the CDSS.

Table 3. Pearson's correlation coefficients among the measures.

n = 242	VAS	Core VAS	SMVM	PGIS	Proc scale	FAS	S-SARS	CDSS
VAS	1	–	0.714	0.662	−0.656	−0.684	−0.279	−0.423
Core VAS	–	1	0.717	0.662	−0.622	−0.615	−0.243	−0.371
SMVM	0.714	0.717	1	0.751	−0.534	−0.562	−0.186	−0.304
PGIS	0.662	0.662	0.751	1	−0.529	−0.492	−0.128	−0.263
Proc Scale	-0.656	-0.622	-0.534	−0.529	1	0.618	0.268	0.365
FAS	-0.684	-0.615	-0.562	−0.492	0.618	1	0.335	0.555
S-SARS	-0.279	-0.243	-0.186	−0.128	0.268	0.335	1	0.552
CDSS	-0.423	-0.371	-0.304	−0.263	0.365	0.555	0.552	1

Table 4. Pearson's correlation coefficients between the VAS and the subscales of the SMVM, PGIS and BISBAS.

n = 242	Empty Cell	VAS (48 items)	Core VAS (27 items)
SMVM	Physical strength	0.644	0.637
	Emotional energy	0.568	0.578
	Cognitive liveliness	0.623	0.631
PGIS	Planfulness	0.609	0.606
	Readiness for change	0.560	0.544
	Intentional behaviour	0.666	0.684
	Using resources	0.455	0.452
BISBAS	Behaviour Inhibition	−0.045	−0.030
	Drive	0.531	0.558
	Reward responsiveness	0.524	0.535
	Fun-seeking	0.421	0.462

3.3. Internal consistency

As presented in Table 5, Cronbach's alpha coefficients among the 48-items of the VAS were high. Cronbach's alphas on sequential item omission all remained close to 0.8. The Cronbach's alpha coefficients for each half of the split VAS were lower, which is in keeping with the theoretical expectation that instruments comprising fewer items result in lower Cronbach's alpha values. Cronbach's alphas for the split-half reliability on the positive and negative VAS categories were also good.

Table 5. Reliability tests for 48-item and 27-item versions of the VAS.

Type of reliability	Scale/items used	Number of items	Cronbach's alpha	Standard error of measurement
Internal consistency	VAS (48 items)	48	0.8	7.01
Internal consistency on sequential item deletion	VAS (48 items)	48	0.79–0.81	N/A
Internal consistency on instrument categories	Positive items of the 48-item VAS	25	0.94	4.15
	Negative items of the 48-item VAS	23	0.88	4.37
Split-half reliability	Consecutive items 1–24 of the Initial 48-item VAS	24	0.61	4.93
	Consecutive items 25–48 of the Initial 48-item VAS	24	0.71	4.94
Test-retest reliability	Initial 48-item VAS	48	0.77	7.39
	Repeat 48-item VAS	48	0.80	7.31
Internal consistency	Core VAS	27	0.82	5.09
Internal consistency on sequential item deletion	Core VAS	27	0.80–0.84	N/A
Split-half reliability	Consecutive items 2, 4, 12, 16, 18, 19, 21, 20, 22, 25, 26, 28, 30, 31 of the Core VAS	14	0.75	3.63
	Consecutive items 32, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 46, 48 of the Core VAS	13	0.72	3.55
Test-retest reliability	Core VAS	27	0.80	5.38
	Repeat of Core VAS	27	0.82	5.31

3.4. Split-half and test-retest reliability

Spearman-Brown and Guttman correlation testing yielded strong correlations (r = 0.72 and 0.71 respectively) between the first and the second halves of the VAS. The set of items phrased in the positive correlated negatively to a moderate degree (r = -0.5) with the set of items phrased in the negative. For test-retest reliability, there was a strong correlation of 0.80 between the VAS scores when repeated.

3.5. Standard error of measurement

As presented in Table 5, the standard error of measurement (SEM) for the total VAS score was approximately seven, subject to a 68% degree of certainty using one standard deviation, as is customary for SEM calculations. This means that within a maximum range of 145 points from the theoretical minimum to the maximum score, the observed total scores were within seven points of the calculated true scores. In terms of internal consistency, this means the total observed score consistently measured what it was supposed to measure, plus or minus seven points.

3.6. Exploratory factor analysis

Preceding an EFA, the Kaiser-Meyer-Olkin test of sampling adequacy (KMO) and Bartlett's test of sphericity were performed. The KMO correlation was 0.9, indicating that the sample size was sufficient. Bartlett's test was statistically significant (approximate chi-square = 5335.80, df = 1128, $p < 0.001$), meaning that the VAS items were significantly related and suited for factor analysis.

Principal Axis Factoring was used for extraction and the Kaiser Criterion was applied, whereby factors with an eigenvalue greater than 1.0 were retained. An oblique factor rotation method was selected (Oblimin with Kaiser Normalization) as it allowed for factors to be correlated. Cross-loading items were removed, as were items for which loading coefficients were less than 0.3.

Twenty-seven VAS items were retained, called the Core VAS, which loaded on six factors (see Table 6 for the pattern matrix of coefficients). These six factors accounted for 62% of total variance among the retained items (see Table 7). Table 8 presents the items that loaded on each of the six factors. Table 9 presents a factor correlation matrix for the Core VAS.

Table 6. Pattern matrix of the Core VAS resulting from the Exploratory Factor Analysis. Strongest correlations between items and factors (r > 0.3)

VAS item	Factor					
	1	**2**	**3**	**4**	**5**	**6**
VAS 34	**0.672**	−0.005	−0.092	−0.029	0.016	−0.017
VAS 36	**0.666**	−0.076	−0.133	0.027	0.054	0.132
VAS 12	**0.625**	0.006	0.047	0.075	0.120	−0.220
VAS 42	**0.507**	0.053	−0.148	−0.155	−0.007	0.087
VAS 28	**0.487**	0.076	−0.033	−0.300	0.047	−0.199
VAS 40	**0.469**	0.060	0.017	−0.008	**0.335**	−0.209
VAS 18	**0.415**	−0.086	0.086	−0.164	0.249	−0.116
VAS 32	**0.400**	0.004	−0.045	−0.213	0.187	0.136
VAS 39	0.176	**0.650**	0.007	0.064	−0.106	0.179
VAS 41	0.006	**0.642**	0.066	0.070	0.066	0.062
VAS 35	−0.154	**0.506**	0.178	−0.206	−0.023	0.006
VAS 19	−0.010	0.167	**0.774**	0.053	−0.004	−0.024
VAS 21	−0.110	0.055	**0.738**	−0.025	0.047	0.130
VAS 46	0.031	0.150	**−0.380**	−0.122	0.275	−0.036
VAS 26	−0.027	−0.019	−0.177	**−0.697**	0.125	−0.030
VAS 30	0.287	0.047	−0.058	**−0.602**	−0.114	−0.155
VAS 22	0.295	−0.247	0.147	**−0.420**	0.192	0.128
VAS 2	0.075	0.001	−0.011	**−0.321**	0.294	−0.084
VAS 48	−0.033	0.058	−0.095	0.036	**0.739**	−0.006
VAS 38	0.191	−0.110	0.004	0.126	**0.655**	−0.033
VAS 4	−0.002	0.069	0.026	−0.051	**0.647**	−0.024
VAS 16	0.217	−0.141	−0.005	0.043	**0.500**	−0.005
VAS 20	−0.060	−0.182	−0.067	−0.269	**0.464**	0.054
VAS 44	0.260	0.168	−0.002	−0.223	**0.364**	−0.032
VAS 25	0.036	0.001	0.233	−0.017	−0.118	**0.624**
VAS 31	0.007	0.234	−0.018	0.048	0.022	**0.518**
VAS 37	−0.152	0.296	−0.004	0.131	0.078	**0.374**

Extraction method: Principal Axis Factoring.

Rotation method: Oblimin with Kaiser Normalization, converged in 17 iterations.

Table 7. The variance explained by a six-factor model for the Core VAS.

Factor		**Eigenvalues (>1.0) based on PCA**		**Extraction sums of squared loadings**		**Rotation sums of squared loadings[a]**	
Empty Cell	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**
1	9.237	34.212	34.212	8.767	32.471	32.471	6.705
2	2.688	9.955	44.167	2.194	8.126	40.597	2.491
3	1.381	5.115	49.282	0.954	3.535	44.132	3.495
4	1.231	4.558	53.840	0.785	2.908	47.040	4.323
5	1.161	4.301	58.141	0.675	2.499	49.539	6.291
6	1.018	3.771	61.911	0.532	1.969	51.508	2.626

Extraction method: Principal Axis Factoring.

[a]When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 8. Items that loaded on the six factors of the Core VAS.

Factor and factor label	Item number	VAS items
1 Task Drive	34	I have been eager to do tasks during the past 7 days.
	36	I have been highly driven during the past 7 days.
	12	During the past 7 days, I have felt energised to do my work or tasks.
	42	I have pushed through and persevered with my tasks or work during the past 7 days even when it got tough.
	28	I have been active in doing my tasks and work during the past 7 days.
	40	I have felt inspired to do my tasks or work during the past 7 days.
	18	I have been really into my tasks or work during the past 7 days.
	32	The tasks I have been doing during the past 7 days have purpose and meaning.
2 Indecisiveness	39	During the past 7 days, I have been postponing decisions that had to be made.
	42	During the past 7 days, I have been back and forth in my mind on what to do.
	35	I have had difficulty in coming to decisions on what to do during the past 7 days.
3 Social disinterest	19	During the past 7 days, I have been uninterested in speaking to others.
	21	During the past 7 days, I have been uninterested in the company of other people.
	46	During the past 7 days, I have returned communications like phone calls, messages and e-mails without delay.
4 Active mobilisation	26	I have taken action during the past 7 days to reach my goals.
	30	During the past 7 days, I have been pursuing my daily goals.
	22	During the past 7 days, I have been going for the things I want.
	2	I have been active and on the move during the past 7 days.
5 Creative efforts	48	I have taken an interest in new things during the past 7 days.
	38	I have been doing creative things during the past 7 days.
	4	I have initiated new plans during the past 7 days.
	16	I have been excited during the past 7 days about doing things.
	20	I made choices and went for them during the past 7 days.
	44	During the past 7 days, I have attempted to improve things in my life.
6 Torpidity	25	I have been slow in doing everyday activities during the past 7 days.
	31	I have felt weak when doing ordinary things during the past 7 days.
	37	During the past 7 days, I have delayed before starting on work or tasks I had to do.

Table 9. Factor correlation matrix for the Core VAS.

	Task drive	Indecisiveness	Social disinterest	Active mobilisation	Creative efforts	Torpidity
Task drive	1.000	−0.162	−0.359	0.457	0.618	−0.218
Indecisiveness	−0.162	1.000	0.273	0.077	−0.107	0.402
Social disinterest	−0.359	0.273	1.000	0.188	−0.343	0.259
Active mobilisation	0.457	0.077	0.188	1.000	−0.451	0.191
Creative efforts	0.618	−0.107	−0.343	−0.451	1.000	−0.200
Torpidity	−0.218	0.402	0.259	0.191	−0.200	1.000

Extraction method: Principal Axis Factoring.

Rotation method: Oblimin with Kaiser Normalization.

3.7. Validity and reliability of the Core VAS

The EFA resulted in a 27-item version of the VAS (i.e., the Core VAS). While improved internal consistency may be expected after an EFA, confirmatory statistical tests were subsequently performed on whether the other psychometric properties still pertained for the Core VAS. As for the 48-item version, moderate to strong correlations confirmed convergent validity between the Core VAS and the relevant instruments, and its discriminant validity was similarly confirmed with weak and/or negative correlations (see Table 3, Table 4). Reliability results for both the 48-item and 27-item versions of the VAS are presented in Table 5. Reducing the number of items would lower Cronbach's alpha coefficients, but these were higher, suggesting improved internal consistency. Split-half and test-retest coefficients as well as the SEM values for the Core VAS were improved.

4. Discussion

The current study reports the validity and the reliability of the VAS, a new self-report measure of vigour designed for use in avolitional schizophrenia outpatients. The VAS is the first instrument for measuring vigour in a psychiatric population, preceded only by the SMVM that measures work-related vigour in a non-clinical setting. Results show excellent psychometric properties, as evidenced by its convergent and discriminant validity, internal consistency, split-half and test-retest reliability, and a clear six-factor correlational structure.

Convergent validity of the VAS was found in its moderate to strong correlations with measures of work-related vigour, planfulness, readiness for change, intentional behaviour, and behaviour activation including drive and reward-responsiveness. As expected, the strongest correlation was between the VAS and the SMVM, as the latter measures specifically vigour, although it is confined to work-related aspects. Discriminant validity was found in the VAS measuring vigour as being unrelated to behaviour inhibition, and inversely correlated with fatigue, depression, anxiety and procrastination.

Whereas the validity results indicated that the VAS measured what it was supposed to measure, the reliability results indicated that the VAS measured consistently, incurring no more than a small error of measurement with observed scores being within seven points of a true score within a scale range of 145 points. Internal consistency was good with Cronbach's alpha coefficients above 0.8, which indicate coherence among the items measuring the same construct, i.e. vigour. Consistency was also found in strong correlations between the halves of the VAS and in the test-retest reliability observed for repeated measurements.

The factor analysis of the VAS demonstrated internal consistency by providing details of the internal structure of the instrument. It also optimised the internal consistency by identifying the clustering of items and progressively eliminating “noise” that undermines consistency. Subjecting the relatively high number of items of the VAS to an EFA facilitated the statistical selection of 27 core items that fit into a tight six-factor structure. The subsequent Core VAS is a refined instrument for which 61.911% of the cumulative variance was explained by an extracted six factor model, captured as Task Drive, Indecisiveness, Social Disinterest, Active Mobilisation, Creative Efforts and Torpidity. This is generally taken as a good outcome for a

new instrument's reliability testing, as per the 50–75% cumulative variance recommended (Mvududu and Sink, 2013).

4.1. Limitations

Results of the study were limited to data from residual-phase schizophrenia outpatients who were 72% male, which is similar to the gender preponderance seen in probabilistic schizophrenia samples (McGrath et al., 2008). The data were also limited to avolitional patients, and vigour in the general schizophrenia population would probably be more. In another way, avolition was also a limiting factor in that participants who were more avolitional appeared to take much more time in completing the assessments in the study. During recruitment of participants, avolition was of such a degree in a small number of patients that it precluded participation in the study.

In addition to limitations pertaining to an EFA (Fabrigar et al., 1999), predictive validity could not be examined in the absence of a "gold" standard. The SMVM could not be suitable as a "gold" standard, being designed for a different population and confined to occupational vigour.

4.2. Future directions

Although avolition is well-recognised in the schizophrenia literature, there is no specific measuring instrument for it other than through a few items of existing scales with a broader scope. This may be one reason for the absence of prior empirical studies on the relation between avolition and vigour. At best, one may infer conceptually that avolition is an inverse approximation of vigour. The development and validation of the VAS affords a measuring instrument crucial for quantified investigations into the relation of vigour with avolition and other symptoms of schizophrenia. Of particular interest would be its relation with the negative symptom factors of motivation-pleasure and expression as captured by the Clinical Assessment Interview for Negative Symptoms (Kring et al., 2013). The VAS may also be used in examining other constructs that are potentially related to vigour including cognitive and physical persistence, effort, and energetic deficits. A measure of vigour furthermore provides an instrument for quantified research into vigour, its neurophysiological, psychological and social associations, its enhancers and impediments, and its relation with functional outcomes and prognosis.

In avolitional schizophrenia patients, a measure of vigour provides the clinical means to assess the extent of vigour as well as whether vigour, as a therapeutic target, would have been gained. For further research, a measure of vigour in this population provides an instrument crucial for efficacy studies on interventions targeting vigour. To this end, the VAS may be validated for further studies that examine vigour in other clinical populations where vigour may be compromised (for example, in depressed patients), as well as in healthy populations where vigour is pursued as a desirable attribute.

In conclusion, these results indicate that the VAS is a valid and reliable instrument in avolitional schizophrenia, evidenced by sound psychometric properties and a clear six-factor correlational structure. The VAS provides the means for further research on vigour in

schizophrenia, and the clinical assessment of vigour when pursued therapeutically in practice or efficacy studies. Subject to further validation, its use may be extended to other populations for which vigour may be at issue or a target of pursuit.

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Declaration of competing interest

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