Comparing factor structures of depressed patients with and without suicidal ideation, a measurement invariance analysis

Ballegooijen, W. van; Eikelenboom, M.; Fokkema, M.; Riper, H.; Hemert, A.M. van; Kerkhof, A.J.F.M.; ... ; Smit, J.H.

Journal of Affective Disorders 245 (2019) 180–187

Contents lists available at ScienceDirect

Journal of Affective Disorders

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

Research paper

Comparing factor structures of depressed patients with and without suicidal ideation, a measurement invariance analysis

Wouter van Ballegooijen[a,b,c,*], Merijn Eikelenboom[a,b], Marjolein Fokkema[d], Heleen Riper[a,b,c], Albert M. van Hemert[e], Ad J.F.M. Kerkhof[c], Brenda W.J.H. Penninx[a,b], Jan H. Smit[a,b]

[a] Amsterdam UMC, Vrije Universiteit, Department of Psychiatry, Amsterdam, The Netherlands
[b] GGZ inGeest Specialised Mental Health Care, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands
[c] Vrije Universiteit Amsterdam, Section Clinical Psychology, Amsterdam, The Netherlands
[d] Leiden University, Department of Methods & Statistics, Leiden, Netherlands
[e] Leiden University Medical Centre, Department of Psychiatry, Leiden, Netherlands

ARTICLE INFO

Keywords:
Depressive disorders
Major depressive disorder
Suicidal ideation
Latent variables
Factor analysis
Measurement invariance

ABSTRACT

Background: Suicidality could be associated with specific combinations of biological, social and psychological factors. Therefore, depressive episodes with suicidal ideation could be different from depressive episodes without suicidal ideation in terms of latent variable structures.

Methods: In this study we compared latent variable structures between suicidal and non-suicidal depressed patients using confirmatory factor analysis (CFA), following a measurement invariance test procedure. Patients (N = 919) suffering from major depressive disorder were selected from the Netherlands Study of Depression and Anxiety (NESDA) and split into a group that showed no symptoms of suicidal ideation (non-SI; N = 691) and a suicidal ideation (SI) group that had one or more symptoms of suicidal ideation (N = 228). Depression and anxiety symptoms were measured using the short form of the Mood and Anxiety Symptoms Questionnaire (MASQ-D30).

Results: CFA implied a difference in latent variable structures between the non-SI sample (CFI 0.957; RMSEA 0.041) and the SI sample (CFI 0.900; RMSEA 0.056). Subsequent multiple-group CFA showed violations of measurement invariance. The General distress and Anhedonic depression subscales were best indicated by hopelessness and lack of optimism in the SI sample and by dissatisfaction and not feeling lively in the non-SI sample. Overall, the SI sample had higher scores and lower inter-item correlations on the Anhedonic depression items.

Limitations: We have included very mild cases of suicidal ideation in our SI sample.

Conclusions: On a latent variable level, depression with suicidal ideation differs from depression without suicidal ideation. Results encourage further research into the symptom structure of depression among suicidal patients.

1. Background

Over 90% of people who died by suicide had mental health problems, most notably affective disorders (Cavanagh et al., 2003), but only 5% of people who experience an affective disorder die by suicide (Bostwick and Pankratz, 2000). Suicidal ideation possibly develops from a vulnerability, which may be biological or genetic, or which could develop in the context of adverse environmental circumstances (e.g. O'Connor, 2011; Schotte and Clum, 1987; Williams et al., 2005). Stress can trigger this vulnerability, for example stress caused by adverse life events, or stress caused by mental health problems, such as a depressive episode (Mann et al., 1999,2005; O'Connor, 2011). Suicidality could therefore be associated with specific combinations of biological and psychological factors (Rudd, 2000; O'Connor, 2011) and could be considered to coincide with a distinct pattern of psychopathology, so a depressive episode with suicidal ideation could be different from a depressive episode without suicidal ideation.

A difference in symptom patterns of depressive episodes between individuals with and without suicidal ideation might be observed in latent variable structures, i.e. the factorial structure of instruments measuring psychopathology may differ between these groups. A well-developed method for testing differences in factorial structures between groups is confirmatory factor analysis (CFA) and subsequent multiple-group confirmatory factor analysis (MGCFA; Sörbom, 1974; Meredith,

* Corresponding author at: Department of Psychiatry, Amsterdam UMC, VU Medical Centre & GGZ inGeest, Oldenaller 1, Amsterdam 1081 HJ, Netherlands.
E-mail address: w.van.ballegooijen@vu.nl (W. van Ballegooijen).

https://doi.org/10.1016/j.jad.2018.10.108
Received 18 November 2017; Received in revised form 5 July 2018; Accepted 16 October 2018
Available online 17 October 2018
0165-0327/

1993; Hirschfeld and Von Brachel, 2014), in which observed item scores are regressed on the underlying latent variables. CFA and MGCFA can be applied to test measurement invariance, which is the assumption that the relations between latent variables and observed item scores are invariant between groups. If that assumption holds, the assessment instrument measures the same construct in the same way in these different groups. That is, the item responses can be taken as indicators of the same latent constructs and, therefore, observed differences in item and/or test scores between samples represent actual differences in the construct of interest (Byrne et al., 1989; Cheung and Rensvold, 1999; Vandenberg and Lance, 2000). A violation of measurement invariance implies that observed differences in questionnaire scores between groups are less meaningful, because the measured constructs differ between groups. Applied to the present subject, the measurement invariance assumption would not hold if the item responses of depressed individuals with suicidal ideation would have a different factorial structure compared with depressed individuals without suicidal ideation.

From a methodological perspective, testing for measurement invariance among suicidal and non-suicidal depressed patients is important for interpreting and comparing questionnaire scores, because only when the same constructs are measured in these groups, they can be compared meaningfully (Byrne et al., 1989). From a clinical perspective, mapping symptom patterns among patients with depression and suicidal ideation could inform clinicians which symptoms to focus on when treating these patients, and could inform development of treatment specific for this group.

In this study, we will compare factorial structures of depressed suicidal and depressed non-suicidal patients using confirmatory factor analysis, following a measurement invariance test procedure using the short form of the Mood and Anxiety Symptoms Questionnaire (MASQ-D30). A violation of measurement invariance would indicate a difference in depression symptom structure between groups.

2. Method

2.1. Participants

2.1.1. Dataset

Data are derived from the Netherlands Study of Depression and Anxiety (NESDA) (Penninx et al., 2008). NESDA is a longitudinal cohort study of the long-term course of depression and anxiety disorders. The baseline assessments of NESDA were conducted between 2004 and 2007 and included a face-to-face assessment of demographic and personal characteristics as well as a standardised psychiatric interview, including questions about suicidal ideation and past suicide attempts. Additionally, self-report questionnaires were filled in by participants, which measured the severity of depressive and anxiety symptoms, among other variables. Initially, 2981 respondents were recruited. To represent depression and anxiety at different levels of severity and development, participants (aged 18–65 years) were recruited from the community (19%), primary care (54%) and specialised outpatient mental health care (27%). Exclusion criteria at baseline were a primary classification of bipolar disorder, obsessive–compulsive disorder, substance use disorder, psychotic disorder, or organic psychiatric disorder, as reported by the participants or their mental health practitioner. The research protocol was approved by the ethical committees of participating universities and all respondents provided written informed consent.

2.1.2. Present study

For the present study, we derived data from the NESDA baseline assessment and selected 1112 participants with a current major depressive disorder, based on the CIDI (6-month) classification.

2.2. Instruments

2.2.1. The Composite International Diagnostic Interview (CIDI)

The CIDI – lifetime version 2.1 (World Health Organization, 1990) was used to ascertain depressive and anxiety disorders according to DSM-IV algorithms. Specially trained clinical research staff conducted the CIDI (Penninx et al., 2008). DSM-IV exclusion rules were used in making classifications, and hierarchy-free classifications were made to allow for research into comorbidity (Penninx et al., 2008). The lifetime CIDI allows for the determination of the history, recency, duration and age of onset of episodes.

2.2.2. Suicidal ideation

The face-to-face interview included the first five items of the Beck Scale for Suicidal Ideation (Beck et al., 1979). The suicidal ideation items were scored 0, 1 or 2 and scores of the five items were added to create a total score. A total score of 1 or higher was regarded as the presence of suicidal ideation.

2.2.3. The Inventory of Depressive Symptomatology (IDS)

We used the 30-item self-report version of the IDS (Rush et al., 1986,1996). The IDS was designed to assess depression symptom severity and symptom change. Principal component analyses suggest the IDS consists of 3 components: mood/cognition, anxiety/somatic and sleep (Rush et al., 1996; Wardenaar et al., 2010b).

2.2.4. MASQ-D30

Depression and anxiety symptoms were assessed using the short form of the Mood and Anxiety Symptoms Questionnaire (MASQ-D30; Wardenaar et al., 2010a). The original MASQ was developed as a 90-item self-report questionnaire that assesses general symptoms of depression and anxiety (Watson et al., 1995a,b). The Likert-type items are scored 1 (not at all) to 5 (extremely). Higher scores indicate more severe symptom severity. The original authors proposed five subscales. Based on a principal component analysis using data of the NESDA study, Wardenaar et al. recommended a theory-driven 3-component structure, each subscale containing 10 items (Wardenaar et al., 2010a). These subscales are: general distress or negative affect; anhedonic depression or lack of positive affect; and anxious or somatic arousal. This shortened version, the MASQ-D30, was used in our analyses. In a study among adolescents it was found that the three-factor model showed better fit when an orthogonal general factor was added, forming a 3-factor bifactor model (Lin et al., 2014), see Fig. 1.

2.3. Analyses

We intended to analyse the factor structures of the IDS and the MASQ-D30, but could not obtain a stable and meaningful factor structure of the IDS (data available on request). Instable factor structures and low factor loadings of several IDS items have been reported before (Wardenaar et al., 2010b), also by the original authors (Rush et al., 1996). Therefore, we used the IDS only to describe the sample and continued our analyses using the MASQ-D30. We tested the model fit of the factor models proposed by Wardenaar et al. (2010a) (model 1) and Lin et al. (2014) (model 2), using CFA with robust full information maximum likelihood (FIML) estimation. FIML estimation is robust for missing data and non-normally distributed data (Enders, 2001). The models were identified by using the marker-item approach, which means that the loading of the first item of every subscale is fixed to 1 and its intercept set to 0. In the tables we report standardised factor loadings, which assume a variance equal to 1 for latent variables, which is easier to interpret. Model fit was interpreted by inspecting fit indices, employing the following rules of thumb: the comparative fit index (CFI) indicates acceptable fit above 0.900 and good fit above 0.950; the root mean squared error of approximation (RMSEA) indicates good fit below 0.060; and the standardised root

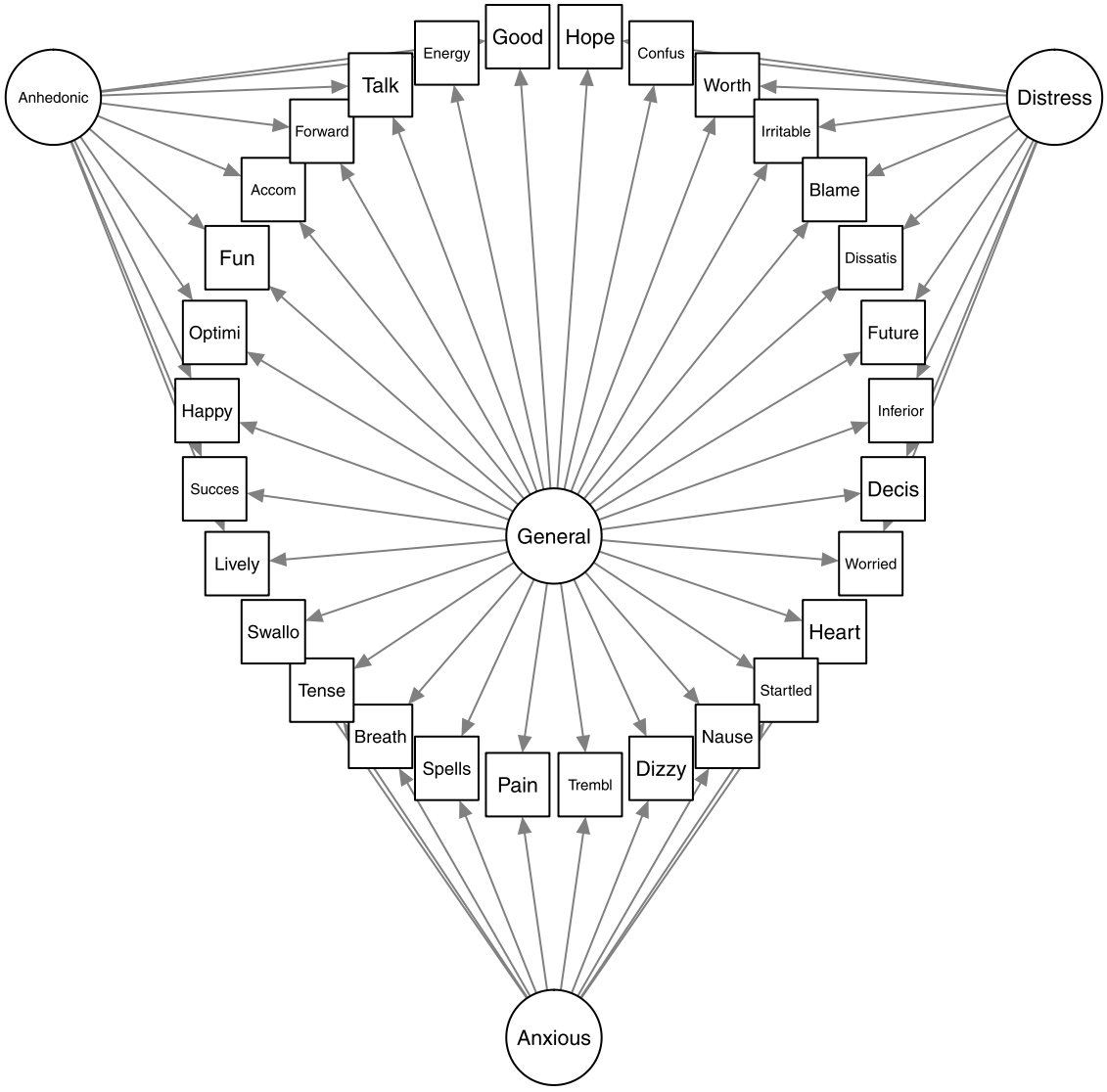

Fig. 1. The bifactor model of the MASQ-D30 (model 2).

mean squared residual (SRMR) indicates good fit below 0.080 (Hu and Bentler, 1999). These fit indices should be considered in combination, so a good fit meets all these criteria (Hu and Bentler, 1999).

Testing for measurement invariance consists of a series of model comparisons that define more and more stringent equality constraints (Hirschfeld and Von Brachel, 2014; Byrne, 2009; Cheung and Rensvold, 1999; Raju et al., 2002; Vandenberg and Lance, 2000). To assess configural invariance, which means invariant factor structures, we tested the fit of both models on the depressed group without suicidal ideation (non-SI sample) and the depressed group with suicidal ideation (SI sample) separately. We inspected fit indices for both groups, including modification indices to optimise the models. If configural invariance could be obtained, we continued with multiple-group confirmatory factor analysis (MGCFA) with increasingly stringent equality constraints. First, a model is fit in which the factor loadings are constrained to be equal between groups, and the fit of this model is compared with the fit of the configural invariance model. Next, factor loadings and item intercepts are constrained to be equal between groups and, finally, factor loadings, intercepts, and residual variances are constrained to be equal between groups. The fit of each model is compared with the fit of the previous (less restricted) model. A rule of thumb is to interpret a difference in CFI of > 0.01 as a significant difference (Cheung and Rensvold, 1999). All analyses were performed in R (R Core Team, 2012), using the packages lavaan (Rosseel, 2012) and qgraph (Epskamp et al., 2012). We maintained a significance level of $p < .05$. R codes and outcomes are provided in appendix B.

3. Results

3.1. Demographics

Of the total NESDA sample, 1112 participants suffered from a major depressive disorder in the past 6 months, of which 919 had completed (most of) the MASQD-30. There were 49 participants who had one or more missing MASQD-30 item responses. The highest number of missing item responses was 4, which was the case for 5 participants. Of the sample of 919 participants with MDD, 228 (24.8%) reported suicidal ideation (SI sample) and 691 (75.2%) reported no suicidal ideation (non-SI sample). There were no statistically significant differences between the groups regarding age, gender and education, but there were differences regarding mental health characteristics, see Table 1. The SI sample showed a slightly younger age of MDD onset, a higher prevalence of dysthymia and anxiety disorders, and higher IDS and MASQ scores. The average Beck Scale for Suicidal Ideation score among the SI sample was 2.81 and 36% had a score of only 1, which can be considered very mild cases of suicide ideation.

Table 1
Demographics and mental health characteristics.

	No suicidal ideation (non-SI sample)	Suicidal ideation (SI sample)	Difference (*p*)
N	691	228	
Mean age (SD)	41.77 (12.15)	41.18 (11.89)	.53
Female (%)	68.1%	64.0%	.26
Higher education[a] (%)	30.6%	31.1%	.87
Mean age of onset MDD (SD)	28.11 (12.81)	25.88 (12.09)	.02
Mean number of depressive episodes (SD)	5.18 (10.21)	4.98 (9.68)	.79
Lifetime dysthymia prevalence (%)	32.2%	50.9%	< .001
Lifetime anxiety disorder prevalence[b] (%)	72.5%	82.0%	.004
Mean IDS Depression severity (SD)	29.39 (12.38)	39.76 (11.84)	< .001
Mean MASQ General distress (SD)	24.10 (8.11)	31.69 (7.74)	< .001
Mean MASQ Anhedonic depression (SD)	38.03 (8.59)	44.17 (6.02)	< .001
Mean MASQ Anxious arousal (SD)	18.05 (6.50)	21.65 (7.49)	< .001

IDS: Inventory of Depressive Symptomatology; MASQ: Mood and Anxiety Symptoms Questionnaire Short Adaptation; MDD: major depressive disorder; SD: standard deviation; SI: suicidal ideation.
[a] Defined as completed higher vocational, college or university education.
[b] General anxiety disorder, social phobia, panic disorder with or without agoraphobia, agoraphobia without panic.

Table 2
Confirmatory factor analysis of the MASQ-D30, using model 1 (Wardenaar et al., 2010a).

	Chi square	DF	CFI	RMSEA (CI)	SRMR	AIC	BIC	Overall fit[a]
Full sample (*N* = 919)	1255.81	402	0.927	0.052 (0.049–0.055)	0.050	70,873	71,322	Acceptable
Non-SI sample (*N* = 691)	971.81	402	0.931	0.049 (0.045 –0.053)	0.052	52,723	53,145	Acceptable
SI sample (*N* = 228)	758.39	402	0.857	0.064 (0.057 –0.071)	0.071	17,752	18,071	Poor

AIC: Akaike information criterion; BIC: Bayesian information criterion; CFI: comparative fit index; CI: 90% confidence interval; DF: degrees of freedom; RMSEA: root mean squared error of approximation; SI: suicidal ideation; SRMR: standardised root mean squared residual.
[a] Following recommendations of Hu and Bentler (1999).

3.2. Measurement invariance

Correlation matrices and all R code and outcomes are provided in Appendices A and B. Model 1 fit the overall data acceptably, see Table 2. The CFI suggested acceptable fit, the RMSEA and SRMR suggested good fit. Similar results were obtained when fitting the model on the non-SI sample only. Fit indices were less good for the SI sample (Table 2). The CFI suggested poor fit, the RMSEA acceptable fit and the SRMR good fit. The RMSEA confidence intervals showed a statistically significant difference in model fit between groups ($p < .001$). We inspected modification indices for the non-SI sample and the SI sample, but the modification indices for the non-SI sample did not match those of the SI sample. Therefore, we could not improve the model fit for both groups.

Model 2 appeared to have good fit according to all fit indices when fit on the full sample (Table 3). Model fit was approximately the same for the non-SI sample only. The CFI suggested acceptable fit for the SI sample and the RMSEA and SRMR suggested good fit. The RMSEA confidence intervals again showed a statistically significant difference in model fit between groups ($p < .001$). Modification indices of the two samples did not match. We continued our analyses using model 2, because it fit both samples better than model 1.

The fit indices pointed to a lack of configural invariance, that is, differing factor structures. We inspected the factor loadings (Table 4) and item correlations (Fig. 2) of the two samples. The inter-item correlations of the Distress and Anhedonic depression subscales were stronger in the Non-SI sample (Fig. 2). Factor loadings differed between groups. The General Distress factor was best indicated by hopelessness (item 10) in the SI sample and dissatisfaction (item 13) in the non-SI sample. The Anhedonic depression factor was best indicated by lack of optimism (item 9) in the SI sample and by not feeling 'up or lively' (item 22) in the non-SI sample. Anxious arousal was best indicated by shortness of breath (item 21) in the SI sample and by pain in chest (item 18) in the non-SI sample. Overall, the SI sample data showed lower factor loadings on the orthogonal general factor and on the Anhedonic depression factor (Table 4). Therefore, we inspected the average variance of the Anhedonic depression items, which was substantially smaller in the SI sample (0.71) than in the non-SI sample (1.19). However, the structure consisting of 3 subscales and 1 orthogonal general factor did seem to hold. Therefore, we did not search for an

Table 3
Confirmatory factor analysis of the MASQ-D30, using model 2 (Lin et al., 2014).

	Chi square	DF	CFI	RMSEA (CI)	SRMR	AIC	BIC	Overall fit[a]
Full sample (*N* = 919)	896.56	372	0.956	0.042 (0.039 –0.046)	0.030	70,501	71,094	Good
Non-SI sample (*N* = 691)	738.01	372	0.957	0.041 (0.036 –0.045)	0.033	52,486	53,045	Good
SI sample (*N* = 228)	626.61	372	0.900	0.056 (0.048 –0.063)	0.053	17,662	18,083	Acceptable

AIC: Akaike information criterion; BIC: Bayesian information criterion; CFI: comparative fit index; CI: 90% confidence interval; DF: degrees of freedom; RMSEA: root mean squared error of approximation; SI: suicidal ideation; SRMR: standardised root mean squared residual.
[a] Following recommendations of Hu and Bentler (1999).

Table 4
Factor loadings of the MASQD-30 among the group without suicidal ideation (Non-SI) and the suicidal ideation (SI) group, using model 2 (Lin et al., 2014). Loadings of 0.500 and higher are shown in bold.

MASQ-D30 item	Non-SI group				SI group			
	General distress	Anhedonic depression	Anxious arousal	General	General distress	Anhedonic depression	Anxious arousal	General
10 Felt hopeless	**0.681**			**0.586**	**0.872**			0.305
1 Felt confused	0.155			**0.620**	0.171			**0.676**
4 Felt worthless	**0.675**			0.422	**0.763**			0.336
7 Felt irritable	0.294			**0.600**	0.330			**0.579**
12 Blamed myself for a lot of things	**0.608**			**0.564**	**0.648**			0.448
13 Felt dissatisfied with everything	**0.711**			**0.543**	**0.765**			0.347
17 Felt pessimistic about the future	**0.595**			0.412	**0.742**			0.167
23 Felt inferior to others	**0.595**			**0.517**	**0.615**			0.414
25 Had trouble making decisions	0.389			**0.684**	0.246			**0.640**
28 Worried a lot about things	0.494			**0.688**	**0.545**			**0.539**
22 Felt really 'up' or lively		**0.837**		0.413		**0.563**		0.088
3 Felt successful		**0.674**		0.330		0.418		0.120
6 Felt really happy		**0.713**		0.389		**0.515**		0.116
9 Felt optimistic		**0.740**		0.385		**0.639**		0.101
11 Felt like I was having a lot of fun		**0.826**		0.373		**0.602**		0.114
14 Felt like I accomplished a lot		**0.753**		0.312		**0.517**		0.124
16 Felt like I had a lot to look forward to		**0.788**		0.271		**0.633**		0.069
19 Felt really talkative		**0.692**		0.183		**0.627**		−0.086
26 Felt like I had a lot of energy		**0.746**		0.419		0.494		0.105
29 Felt really good about myself		**0.725**		0.433		**0.525**		0.192
27 Heart was racing or pounding			**0.588**	**0.526**			**0.713**	**0.592**
2 Startled easily			0.028	**0.664**			0.244	**0.847**
5 Felt nauseous			0.298	0.238			0.250	0.421
8 Felt dizzy or light-headed			0.467	0.478			0.306	**0.646**
15 Was trembling or shaking			0.367	**0.552**			0.444	**0.671**
18 Had pain in my chest			**0.593**	0.279			**0.585**	0.173
20 Had hot or cold spells			0.458	0.458			**0.646**	**0.534**
21 Was short of breath			0.497	0.273			**0.801**	0.333
24 Muscles were tense or sore			0.327	**0.708**			0.404	**0.691**
30 Had trouble swallowing			0.209	0.307			0.362	0.234

alternative measurement model for the SI sample and we continued with MGCFA (Table 5), bearing in mind that the configural invariance assumption was violated. Constraining item loadings, intercepts and residuals to be equal in both groups all resulted in significant deteriorations of model fit. Constraining item residuals also resulted in a decrease of the CFI of more than 0.01.

3.3. Sensitivity analyses

Because the SI sample had significantly more severe depressive symptoms compared with the non-SI sample, we matched the non-SI sample with the SI sample based on IDS total score and repeated the CFAs. Matching was conducted using the MatchIt package (Ho et al., 2011), matching each SI case with its nearest non-SI case, creating two groups of equal size (N = 225 each) and equal average IDS score (SI sample IDS mean = 40.66, SD = 9.66; non-SI sample IDS mean = 40.12, SD = 9.21; p = .54). Although the difference was less pronounced, the SI sample still showed weaker fit than the non-SI sample based on the CFI and configural invariance could not be assumed (Table 6). The matched non-SI sample showed similar factor loadings compared with the full non-SI sample, except that the Anhedonic depression factor was best indicated by not having a lot of fun (item 11), instead of not feeling 'up or lively' (item 22).

The matched groups also allowed head-to-head comparisons of mean item scores (Appendix C). Despite matching the samples based on IDS total scores, the SI sample had higher mean scores on several items of the General distress and Anhedonic depression subscales, although the differences were small. High Anhedonic depression item-mean scores and small standard deviations pointed to a ceiling effect in the SI sample, which could explain lower inter-item correlations of that subscale shown in Fig. 2.

We also attempted to re-run the analyses accounting for the ordinal nature of the MASQ-D30 items, using diagonally weighted least squares (WLSMV) estimation. Three items of the MASQ-D30 had to be dropped (3, 18 and 22), because some item categories were missing in the SI sample. The model of the SI sample did not converge using model 2 (Lin et al., 2014), but it did converge when using model 1 (Wardenaar et al., 2010a). Compared with the maximum likelihood estimated models, we observed increased fit according to the CFI and decreased fit according to the RMSEA. Overall, fit indices indicated better fit among the non-SI sample (CFI = .964, RMSEA = .057) than among the SI sample (CFI = .926, RMSEA = .066) and configural invariance could not be assumed, confirming the results of the main analysis.

4. Discussion

We compared latent variable structures of depressed patients with and without suicidal ideation using the MASQ-D30. Confirmatory factor analyses of model 2 showed good fit in the non-SI sample and acceptable fit in the SI sample. Fit indices indicated a difference in latent variable structures. Factor loadings and correlation networks showed that the Anhedonic depression factor and the orthogonal general factor were less cohesive among the SI sample, although the 3-factor measurement model of the MASQ-D30 was still confirmed. Subsequent measurement invariance testing showed that measurement invariance cannot be assumed. Sensitivity analyses involving samples matched on depression severity and taking the ordinal nature of the MASQ-D30 items into account yielded similar results. The difference in factor

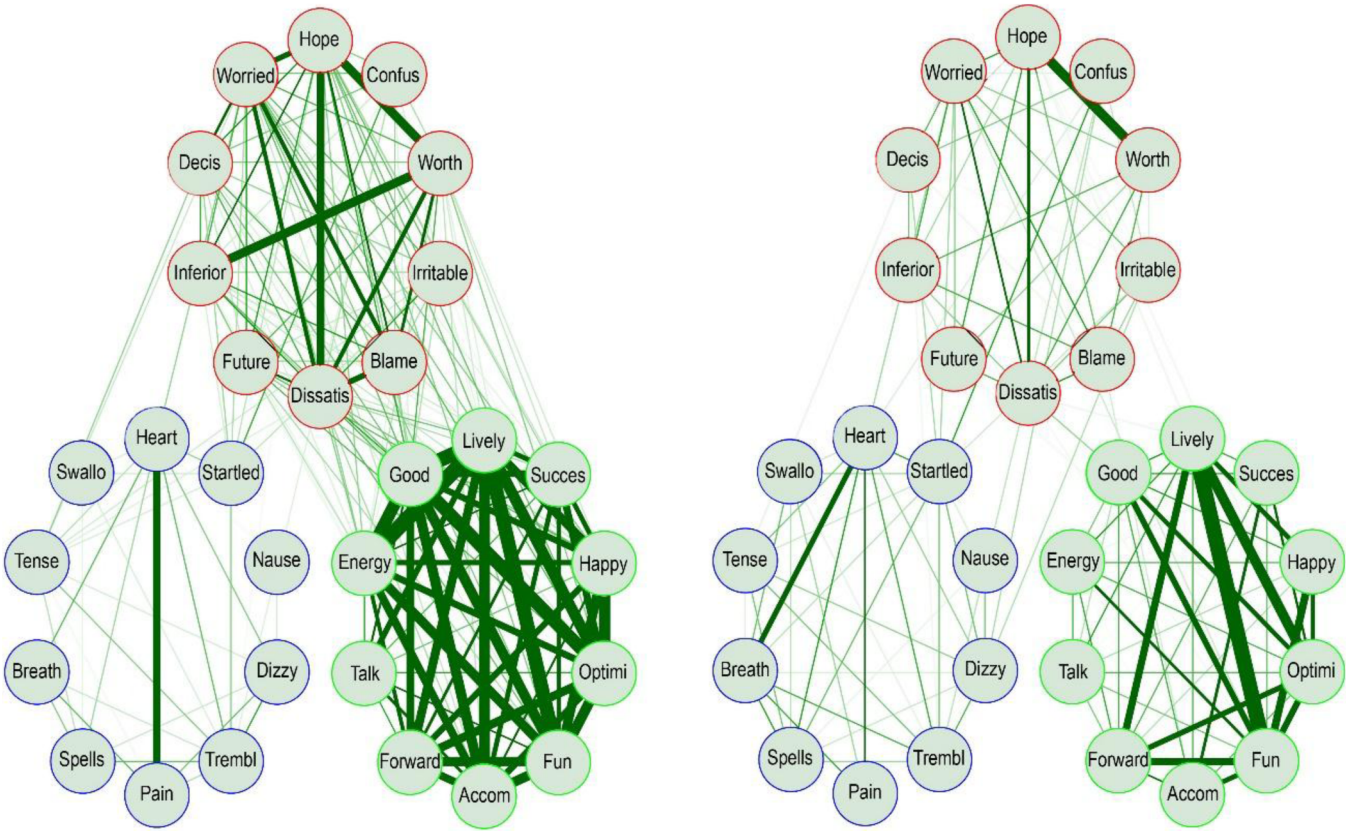

Fig. 2. Correlation structures of the non-SI sample (left) and SI sample (right). Correlations below 0.3 are left out, correlations of 0.5 and higher are shown in bold.

Table 5
Measurement invariance analysis of the MASQD-30, using model 2.

	Chi square	Df	*p*	CFI	RMSEA	AIC	BIC
Configural (equal factor structure between groups)	1370.96	744		0.945	0.045	70,083	71,270
Weak (constrained loadings)	1451.22	800	0.01	0.942	0.044	70,072	70,988
Strong (constrained loadings, intercepts)	1534.34	826	< 0.001	0.937	0.045	70,108	70,899
Strict (constrained loadings, intercepts, residuals)	1685.29	856	< 0.001	0.925	0.049	70,250	70,896

AIC: Akaike information criterion; BIC: Bayesian information criterion; CFI: comparative fit index; DF: degrees of freedom; RMSEA: root mean squared error of approximation.

structure may imply a difference in symptom structure. The General distress and Anhedonic depression subscales were best indicated by hopelessness and lack of optimism in the SI sample and by dissatisfaction and not feeling lively in the non-SI sample. Overall, the SI sample had high scores on the Anhedonic depression items and showed a possible ceiling effect on that subscale.

4.1. Clinical considerations

Our finding that hopelessness and lack of optimism were important indicators of depression among patients with suicidal ideation corresponds to the literature. Previous studies have shown that suicidal depressed patients may develop a distinct cognitive reactivity to sad mood, characterised by hopelessness reactivity (Antypa et al., 2010), possibly because suicidal patients link depression and anxiety symptoms to suicidality (Antypa et al., 2010; O'Connor, 2011; Williams et al., 2005). Clinicians should be aware that when a patient's depression is characterised by hopelessness and overall anhedonia, this may point to coinciding suicidal ideation. Additionally, treatment of depression among patients with suicidal ideation could focus on hopelessness,

Table 6
Confirmatory factor analysis of the MASQ-D30, using model 2 (Lin et al., 2014) and matching the non-SI sample with the SI sample based on depression severity (IDS total score).

	Chi square	DF	CFI	RMSEA (CI)	SRMR	AIC	BIC	Overall fit[a]
Full sample (N = 450)	616.82	372	0.941	0.041 (0.035 –0.046)	0.039	35,019	35,522	Acceptable
Non-SI sample (N = 225)	549.61	372	0.927	0.048 (0.039 –0.056)	0.048	18,054	18,474	Acceptable
SI sample (N = 225)	633.95	372	0.897	0.056 (0.049 –0.064)	0.053	17,516	17,937	Poor

AIC: Akaike information criterion; BIC: Bayesian information criterion; CFI: comparative fit index; CI: 90% confidence interval; DF: degrees of freedom; RMSEA: root mean squared error of approximation; SI: suicidal ideation; SRMR: standardised root mean squared residual.

[a] Following recommendations of Hu and Bentler (1999).

because it may be a central aspect of depression among this group. Our findings concerning differences in depressive symptoms between patients with and without suicidal ideation warrant further exploration of symptom structures, for example using network analysis, which could provide more insight into which symptoms are central to depression in which particular group of patients, which could inform development of specific treatments.

4.2. Psychometric considerations

Model 2 (i.e. the bifactor model of Lin et al. (2014)) is a good measurement model of the MASQ-D30, although the fit among the SI sample was less optimal. The MASQ-D30 was designed to consist of 3 subscales (Wardenaar et al., 2010a) and this measurement model has been confirmed by our analyses, but our results show it is important to consider it as a bifactor model, including an orthogonal general factor. Only when including this general factor, the measurement model of the MASQ-D30 attains good fit among non-suicidal patients and acceptable fit among suicidal patients. The presence of a general orthogonal factor could mean that the MASQ-D30 measures a single construct such as psychological distress, which explains part of the item variance (Reise et al., 2010). It could also point to a 'nuisance' factor (Reise et al., 2010), such as common method bias. Common method bias means that observed variances are partially attributed to the measurement method instead of constructs that the questionnaire represents (Podsakoff et al., 2003). A shared psychopathology factor may be less likely, because the MASQ-D30 was designed to investigate the shared and distinctive features of anxiety and depression (Wardenaar et al., 2010a) and the anhedonic depression and anxious arousal subscales do not correlate strongly with one another (Wardenaar et al., 2010a). A common method bias could be more likely. Factor loadings on this general factor were lower within the SI sample than within the non-SI sample, which may be attributed to distinct response behaviour.

4.3. Strengths and limitations

The strength of this study is that, by using the NESDA sample, we were able to select samples of depressed patients with and without suicidal ideation that were comparable in terms of gender and age. With > 6 indicators per factor, the two groups in the current study had adequate sample size for estimating a CFA model, according to the recommendations of Wolf et al. (2013). A limitation is that we defined suicidal ideation as a score of 1 or more using the first 5 items of the Beck Scale for Suicidal Ideation. Therefore, we have included very mild cases of suicidal ideation in our SI sample. Additionally, there could be other factors than the presence of suicidal ideation that accounted for the difference in symptom structures, such as symptom severity or the duration of depressed symptoms. This would not alter our conclusions, however, because these factors coincide with suicidal ideation. Sensitivity analyses that accounted for symptom severity confirmed our results. Finally, symptom structures can differ for each individual patient. Our analyses were on the aggregated level and can only provide information on suicidal depressed patients as a group.

5. Conclusion

Measurement invariance analysis showed a less good model fit on data of suicidal depressed patients compared with non-suicidal depressed patients, which could imply a difference in symptom structure. Depression factors were best indicated by hopelessness and lack of optimism among patients with suicidal ideation, and by dissatisfaction and not feeling lively among patients without suicidal ideation. To our knowledge, this is the first study to explore differences in factor structures between suicidal and non-suicidal depressed patients. Our results, albeit tentative, encourage further research into the symptom structure of suicidal depressed patients.

Conflict of interest

All authors declare that they have no conflicts of interest.

Contributors

WvB, ME, HR and JHS designed the study. WvB and MF undertook the statistical analysis. WvB wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Acknowledgements

The infrastructure for the NESDA study (http://www.nesda.nl) is funded through the Geestkracht program of the Netherlands Organization for Health Research and Development (ZonMW, grant number 10–000–1002) and financial contributions by participating universities and mental health care organizations (VU University Medical Center, GGZ inGeest, Leiden University Medical Center, Leiden University, GGZ Rivierduinen, University Medical Center Groningen, University of Groningen, Lentis, GGZ Friesland, GGZ Drenthe, Rob Giel Onderzoekscentrum).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2018.10.108.

References

Antypa, N., Van der Does, A.W., Penninx, B.W., 2010. Cognitive reactivity: investigation of a potentially treatable marker of suicide risk in depression. J. Affect. Disord. 122 (1), 46–52.
Beck, A.T., Kovacs, M., Weissman, A., 1979. Assessment of suicidal intention: the Scale for Suicide Ideation. J. Consult. Clin. Psychol. 47 (2), 343.
Bostwick, J.M., Pankratz, V.S., 2000. Affective disorders and suicide risk: a reexamination. Am. J. Psychiatry 157 (12), 1925–1932.
Byrne, B.M., 2009. Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming. CRC Press.
Byrne, B.M., Shavelson, R.J., Muthén, B.O., 1989. Testing for equivalence of factor covariance and mean structures: the issue of partial measurement invariance. Psychol. Bull. 105, 456–466.
Cavanagh, J.T., Carson, A.J., Sharpe, M., Lawrie, S.M., 2003. Psychological autopsy studies of suicide: a systematic review. Psychol. Med. 33 (03), 395–405.
Cheung, G.W., Rensvold, R.B., 1999. Testing factorial invariance across groups: a reconceptualization and proposed new method. J. Manag. 25 (1), 1–27.
Enders, C.K., 2001. The impact of nonnormality on full information maximum-likelihood estimation for structural equation models with missing data. Psychol. Methods 6 (4), 352.
Epskamp, S., Cramer, A.O., Waldorp, L.J., Schmittmann, V.D., Borsboom, D., 2012. qgraph: Network visualizations of relationships in psychometric data. J. Stat. Software 48 (4), 1–18.
Hirschfeld, G., von Brachel, R., 2014. Multiple-Group confirmatory factor analysis in R – a tutorial in measurement invariance with continuous and ordinal indicators. Pract. Assess. Res. Eval. 19 (7), 2.
Ho, D.E., Imai, K., King, G., Stuart, E.A., 2011. MatchIt: nonparametric preprocessing for parametric causal inference. J. Stat. Software 42 (8), 1–28.
Hu, L.T., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equation Model.: Multidiscip. J. 6 (1), 1–55.
Lin, A., Yung, A.R., Wigman, J.T., Killackey, E., Baksheev, G., Wardenaar, K.J., 2014. Validation of a short adaptation of the mood and anxiety symptoms questionnaire (MASQ) in adolescents and young adults. Psychiatry Res. 215 (3), 778–783.
Mann, J.J., Apter, A., Bertolote, J., Beautrais, A., Currier, D., Hendin, H., 2005. Suicide prevention strategies: a systematic review. J. Am. Med. Ass. 294, 2064–2074.
Mann, J.J., Waternaux, C., Haas, G.L., Malone, K.M., 1999. Towards a clinical model of suicidal behavior in psychiatric patients. Am. J. Psychiatry 156, 181–189.
Meredith, W., 1993. Measurement invariance, factor analysis and factorial invariance. Psychometrika 58 (4), 525–543.
O'Connor, R.C., 2011. Towards an integrated motivational–volitional model of suicidal behaviour. International Handbook of Suicide Prevention: Research, Policy and Practice, pp. 181–198.
Penninx, B.W., Beekman, A.T., Smit, J.H., Zitman, F.G., Nolen, W.A., Spinhoven, P., Van Dyck, R., 2008. The Netherlands study of depression and anxiety (NESDA): rationale, objectives and methods. Int. J. Methods Psychiatr. Res. 17 (3), 121–140.
Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y., Podsakoff, N.P., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J. Appl. Psychol. 88 (5), 879.

R Core Team, 2012. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from. http://www.R-project.org/.
Raju, N.S., Laffitte, L.J., Byrne, B.M., 2002. Measurement equivalence: a comparison of methods based on confirmatory factor analysis and item response theory. J. Appl. Psychol. 87 (3), 517.
Reise, S.P., Moore, T.M., Haviland, M.G., 2010. Bifactor models and rotations: Exploring the extent to which multidimensional data yield univocal scale scores. J. Pers. Assess. 92 (6), 544–559.
Rosseel, Y., 2012. Lavaan: an R package for structural equation modelling and more. Version 0.5-12 (BETA). J. Stat. Software 48 (2), 1–36.
Rudd, M.D., 2000. The suicidal mode: a cognitive-behavioral model of suicidality. Suicide Life Threat. Behav. 30 (1), 18–33.
Rush, A.J., Giles, D.E., Schlesser, M.A., Fulton, C.L., Weissenburger, J., Burns, C., 1986. The Inventory for Depressive Symptomatology (IDS): preliminary findings. Psychiatry Res. 18 (1), 65–87.
Rush, A.J., Gullion, C.M., Basco, M.R., Jarrett, R.B., Trivedi, M.H., 1996. The Inventory of Depressive Symptomatology (IDS): psychometric properties. Psychol. Med. 26 (03), 477–486.
Schotte, D.E., Clum, G.A., 1987. Problem-solving skills in psychiatric patients. J. Consult. Clin. Psychol. 55, 49–54.
Sörbom, D., 1974. A general method for studying differences in factor means and factor structure between groups. Br. J. Math. Stat. Psychol. 27, 229–239.
Vandenberg, R.J., Lance, C.E., 2000. A review and synthesis of the measurement invariance literature: suggestions, practices, and recommendations for organizational research. Organ. Res. Methods 3 (1), 4–70.
Wardenaar, K.J., van Veen, T., Giltay, E.J., de Beurs, E., Penninx, B.W., Zitman, F.G., 2010a. Development and validation of a 30-item short adaptation of the Mood and Anxiety Symptoms Questionnaire (MASQ). Psychiatry Res. 179 (1), 101–106.
Wardenaar, K.J., van Veen, T., Giltay, E.J., den Hollander-Gijsman, M., Penninx, B.W., Zitman, F.G., 2010b. The structure and dimensionality of the Inventory of Depressive Symptomatology Self Report (IDS-SR) in patients with depressive disorders and healthy controls. J. Affect. Disord. 125 (1), 146–154.
Watson, D., Weber, K., Assenheimer, J.S., Clark, L.A., Strauss, M.E., McCormick, R.A., 1995a. Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. J. Abnorm. Psychol. 104, 3–14.
Watson, D., Clark, L.A., Weber, K., Assenheimer, J.S., Strauss, M.E., McCormick, R.A., 1995b. Testing a tripartite model: II. Exploring the symptom structure of anxiety and depression in student, adult, and patient samples. J. Abnorm. Psychol. 104, 15–25.
Williams, J.M.G., Barnhofer, T., Crane, C., Beck, A.T., 2005. Problem-solving deteriorates following mood challenge in formerly depressed patients with a history of suicidal ideation. J. Abnorm. Psychol. 114, 421–431.
Wolf, E.J., Harrington, K.M., Clark, S.L., Miller, M.W., 2013. Sample size requirements for structural equation models an evaluation of power, bias, and solution propriety. Educ. Psychol. Meas. 73 (6), 913–934.
World Health Organisation, 1990. Composite International Diagnostic Interview. World Health Organisation, Geneva, Switzerland.