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A bifactor approach to modelling the Rosenberg Self Esteem Scale

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ABSTRACT

Inconsistency exists in the empirical literature with respect to the underlying factor structure of the Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1989). In research contexts the RSES is considered a unidimensional measure of self-esteem. Empirical findings have undermined this conceptualisation with factor analytic findings favouring a variety of one-factor solutions (with correlated measurement errors) or multidimensional representations. The current study applied a bifactor modelling approach to provide a theoretical and methodologically satisfying resolution to the current inconsistency. Three alternative factor models of the RSES were tested among a large sample of the adult population ($N = 6082$). Results indicated that a bifactor model was the best fit of the data. This model was demonstrated to be factorially invariant among males and females. The reliability of the scale was established using composite reliability. Results are discussed in terms of resolving the debate about the appropriate factor structure of the RSES.

1. Introduction

The concept of self-esteem is one of the most widely investigated in all areas of psychological research. There is a considerable body of empirical evidence attesting to the power of self-esteem to buffer against negative mental health effects that can occur as a consequence of experiencing distressing stimuli (Pyszczynski, Greenberg, Solomon, Arndt, & Schimel, 2004). Research findings have indicated that lower levels of self-esteem play a significant role in the development of clinical depression (Brown, Andrews, & Bifulco, 1990). Self-esteem is also emerging as a predictor of positive mental health (Lyubomirsky, Tkach, & Dimatteo, 2006).

The Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1989) is the most widely used measure of self-esteem and was developed based upon Rosenberg's theory of a unidimensional structure of self-esteem. The 10 items that comprise the scale were hypothesised to capture a single latent factor. Results of confirmatory factor analyses (CFA) undermine this conceptualisation and indicate that the RSES is, almost without exception, multidimensional in nature (Huang & Dong, 2012).

It has been argued that the use of both positively and negatively worded items in the RSES results in the occurrence of unwanted method effects which have the consequence of artificially increasing or decreasing the covariation among observable indicators (Bagozzi, 1993). Researchers have resorted to the strategy of correlating error terms to control for these method effects. These correlated error models suggest the presence of a single latent factor representing global self-esteem and correlated error variances among the positively worded items and/or the negatively worded items (e.g., Vasconcelos-Raposo, Fernandes, Teixeira, & Bertelli, 2011). The process of correlating measurement errors has been heavily criticised with various authors stating that error variances should never be correlated in order to improve model fit as such procedures imply the presence of an additional unspecified latent construct, and that introduction of correlated error variances can lead to difficulties in interpretation and replication (Bollen, 1989).

Multidimensional factorial representations have also been proposed to adequately explain the latent structure of the RSES. A large body of research indicates that the RSES can be appropriately conceptualised as a two-factor solution represented by positive and negative aspects of self-esteem (e.g., Kaufman, Rasinski, Lee, & West, 1991). In two recent studies, Boduszek, Shevlin, Mallett, Hyland, and O'Kane (2012), Boduszek, Hyland, Dhingra, and Mallett (2013) demonstrated that the two-factor model of the RSES was a substantially better representation of the latent structure of the scale among prisoners, than the unidimensional solution. Huang and Dong (2012) performed a meta-analysis of 23 studies consisting of 80 independent samples ($N = 32,491$). Their

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results were somewhat inconsistent with results suggesting the superiority of a two-factor model of self-esteem. However the two factors were generally so highly correlated that the authors recommended that the one-factor solution of RSES was superior.

The inconsistent and unsatisfactory model results suggest that traditional methods of assessing the latent structure of the RSES are lacking. A possible method of satisfactorily resolving the issue of the latent structure of the RSES, both theoretically and methodologically, exists with the use of confirmatory bifactor modelling procedures (see Reise, Moore, & Haviland, 2010). Bifactor modelling provides an empirically and conceptually distinct alternative to traditional CFA model solutions wherein covariation among observable indicators is assumed to be explained by both 'general factors' and 'grouping factors', which exist at the same conceptual level. This approach offers a more sophisticated method of controlling for possible method effects inherent in the RSES than correlating error variances. It is also theoretically satisfying as such a conceptualisation includes a single latent factor of self-esteem which is proposed to explain the majority of item covariation, however two other grouping latent factors, consistent with a large body of existing research (Huang & Dong, 2012), can also be modeled in a hierarchical fashion. These two factors represent positive self-esteem (PSE) and negative self-esteem (NSE) and can be viewed as method factors arising as a consequence of item covariation occurring due to the positive and negative wording of the respective items. This bifactor modelling approach, therefore, has the advantage of being capable of distinguishing error variance and method variance among the observable indicators, and being consistent with Rosenberg's initial theoretical prediction of a single meaningful construct of self-esteem.

A comprehensive assessment of the structure of the RSES was recently conducted by Marsh, Scalas, and Nagengast (2010) using longitudinal data collected across an eight year period with a large representative sample of UK adolescents. Marsh et al. investigated eight models of the RSES including a unidimensional structure, a two-factor model of self-esteem, a series of one-factor models with correlated error variances, and a variety of bifactor model conceptualisations. Results from the longitudinal analysis provided no support for the unidemsional model; little support for the two-factor model or the series of one-factor models with correlated error variances. Contrastingly, strong support was found for a bifactor conceptualisation that included a single general factor of self-esteem and two grouping factors represented by PSE and NSE.

Previous research has found evidence of invariant factor structure and factor loadings between males and females (e.g., Byrne & Shavelson, 1987). However, such studies have largely failed to account for method effects associated with item wording. DiStefano and Motl (2006) reported that there were no differences between males and females at the structural, configural, and metric levels, when method effects associated with negatively worded items were controlled for.

The results from the study of Marsh et al. (2010) provide strong support for the accuracy of a bifactor model conceptualisation of the RSES. The current study is performed in order to extend the findings of Marsh and colleagues in a number of important ways. The current article aims to: (i) establish the validity of this bifactor conceptualisation of the RSES within a large sample of the adult population; (ii) test for factorial invariance between males and females; and (iii) assess the composite reliability of the scale. Based on Marsh et al.'s (2010) findings, we expected that a bifactorial model, including one general factor (global self-esteem), and two method/grouping factors (PSE and NSE) would be the best fit of the data. Additionally, in line with previous research indicating that the RSES does not differ substantially in its dimensionality as a function of gender (DiStefano & Motl, 2006), it was expected that the RSES would demonstrate factorial invariance across genders.

2. Method

2.1. Participants

The sample consisted of 6082 participants (68.5%, n = 458 male) identified in National Survey of American Life (NSAL). The NSAL is a comprehensive study of mental health conducted in the USA between February 2001 and June 2003 and it is a part of a National Institute of Mental Health Collaborative Psychiatric Epidemiology Surveys initiative. The NASAL adult sample, all 18 years and older, is an integrated national household probability sample of 3570 African Americans, 1621 Blacks of Caribbean descent, and 891 non-Hispanic whites who live in areas where at least 10% of the population is Black. For more information on the survey and collected data see the methodological paper published by Jackson et al. (2004).

2.2. Measure

The Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1989). The RSES consists of 10 Likert-type scale items designated to assess positive and negative evaluations of the self. Respondents indicate their level of agreement ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). Thus, the possible total score can range from a minimum of 10 to a maximum of 40, with higher scores reflecting more positive evaluations of the self.

2.3. Analysis

The dimensionality of the RSES was investigated through the use of CFA techniques, and confirmatory bifactor modelling. Three alternative model of the latent factor structure of the RSES were specified and estimated using Mplus version 6.0 (Muthen & Muthen, 1998, 2010) with robust maximum likelihood (MLR) estimation. Two models were estimated as CFA conceptualisations. Within these models items were restricted to load onto a single factor, while in the bifactor model each item was allowed to load onto a general factor (self-esteem) and one grouping factor (PSE or NSE), as per recommendations (Reise et al., 2010). In all cases measurement error terms remained uncorrelated as suggested in previous research (Boduszek et al., 2013).

Model 1 is a one-factor solution in which the 10 items of the RSES load on a single latent variable. Model 2 is a correlated two-factor model in which the two latent variables are represented by PSE (items 1, 3, 4, 7, 8, 10) and NSE (items 2, 5, 6, 8, 9). Model 3 (Fig. 1) is a bifactor conceptualisation containing three latent factors; a single general factor of self-esteem (SE) and two grouping/method factors represented by PSE and NSE. Within this model, all 10 items load onto the general SE factor and items 1, 3, 4, 7, 8, 10 also load on the PSE factor while items 2, 5, 6, 8, 9 also load onto the NSE factor. Within a bifactor model the grouping factors are restricted to be uncorrelated with each other and uncorrelated with the general self-esteem factor. For the purposes of model identification the variance of each factor is set to 1.0.

The overall fit of each model and the relative fit between models were assessed using a range of goodness-of-fit statistics and assessment of the appropriateness of the model parameters. The chi-square (χ^2) statistic assesses the sample and implied covariance matrix and a good fitting model is indicated by a non-significant result. However, the χ^2 statistic is strongly associated with sample size, and as such good models tend to be over-rejected. Tanaka (1987) suggested that a model should not be rejected simply on the basis of a significant χ^2 result. According to Kline (1994) models with a χ^2-to-df ratio of less than 3:1 represent a good fitting model. The Comparative Fit Index (CFI; Bentler, 1990) and

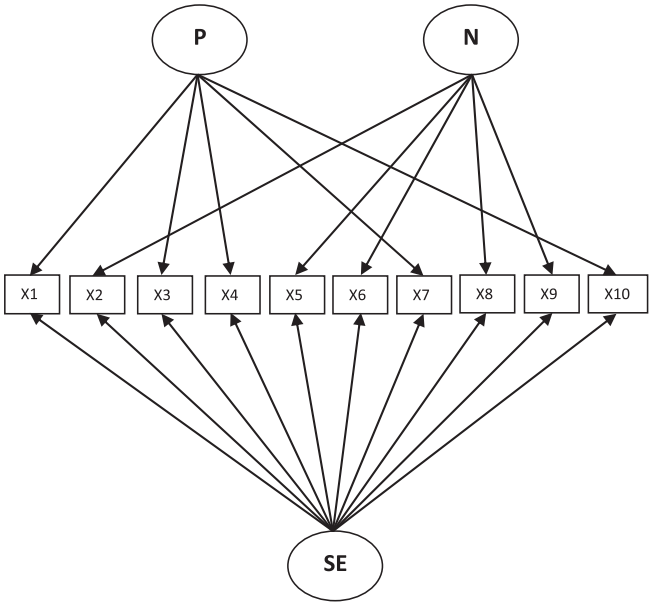

Fig. 1. Bifactor model of Rosenberg Self-Esteem Scale. *Note:* P = Positive Self-Esteem; N = Negative Self-Esteem; SE = Self Esteem.

the Tucker Lewis Index (TLI; Tucker & Lewis, 1973) are measures of how much better the model fits the data compared to a baseline model where all variables are uncorrelated. For these indices values above .95 indicate good model fit (Bentler, 1990). In addition, two more absolute indices are presented; the standardized root mean-square residual (SRMR: Joreskog & Sorbom, 1981) and the root mean-square error of approximation (RMSEA: Steiger, 1990). Good fitting models are indicated by values less than 0.05 (Joreskog & Sorbom, 1993). Furthermore, Akaike Information Criterion (AIC; Akaike, 1974) was used to evaluate alternative models with the smaller value indicating the better fitting model.

3. Results

The mean RSES score for the entire sample was 13.96 (SD = 4.31). The scores for men (M = 13.98, SD = 4.35) and women (M = 13.93, SD = 4.24) were not significantly different, t (5847) = .48, p = .64.

3.1. Model results and tests of invariance

Table 1 reports the fit indices and comparative fit indices of the alternative models of the RSES. Model 1 (the unidimensional structure) was rejected as a poor approximation of the data. The two-factor model of the RSES (Model 2) was found to be an adequate model, however improvements were observed across all fit indices for the bifactor solution (Model 3). Results indicate that this solution was a good fit of the data. The bifactor model also displayed a lower AIC value than the alternative models further indicating its statistical superiority.

The adequacy of this model can also be determined in relation to its parameter estimates. Table 2 indicates that all items displayed statistically significant factor loadings on the general SE factor. Factor loadings were all in the expected direction and exhibited factor loading above .40 with the exception of item 8 (λ = .34). Further inspection of the factor loadings for the two grouping/method factors provides critical information regarding the appropriateness of including these factors in the scoring of the RSES. Reise et al. (2010) advise that when items load strongly onto a general factor, and comparatively weaker on each of the grouping factors, this provides support for consideration of a unidemsional scoring scheme. Alternatively, when items load as strongly, or more strongly, onto each of the respective grouping factors than they do the general factor, creation of subscales is appropriate.

Factor loadings for each grouping factor were comparatively weaker than those on the general SE factor however it should be noted that the NSE factor displayed robust factor loadings. Four of the five factor loadings for the PSE factor were statistically significant with the majority recording weak relationships to the latent factor (see Table 2). These results provide support for the supremacy of a single SE latent factor, and the presence of two method effect factors.

Tests of factorial invariance were conducted between men (N = 2212) and women (N = 3683) using the bifactor solution as the baseline model. Following the procedure of Bollen (1989), a hierarchy of increasingly restrictive models were specified and tested. The test of invariance of form, or that the bifactor model held in both samples, was supported, $\chi^2(53, N = 5895) = 271.37$, $p < .0001$; RMSEA = .04 [.03–.04]; CFI = .97; TLI = .95; SRMR = .03), as was the test of equal factor loadings, $\chi^2(70, N = 5{,}895) = 270.594$, $p < .0001$; RMSEA = .03 [.03–.04]; CFI = .97; TLI = .96; SRMR = .04). Assessment of invariance in factor variances could not be conducted due to the necessity to constrain factor variances to 1.0 in order that a bifactor solution could be identified. These results indicate that the RSES is factorially invariant between males and females.

3.2. Reliability analysis

The use of traditional measures of internal reliability have been criticised within a latent variable modelling context given the propensity to over- or under-estimate scale reliability (Raykov, 1998). In order to provide a rigorous assessment of the internal reliability of the RSES items, composite reliability was performed. Values greater than .60 are generally considered acceptable (Bagozzi & Yi, 1988; Diamantopoulos & Winklhofe, 2001). Current results indicate that the general SE factor of the RSES possesses satisfactory internal consistency (ρ_c = .79). In contrast, the internal reliability for the two grouping factors were lower (PSE, ρ_c = .29; NSE, ρ_c = .61).

Table 1
CFA and bifactor model fit indices for three alternative models of the RSES.

	χ^2	df	CFI	TLI	RMSEA	SRMR	AIC
Models							
1. Factor model	1380.362*	35	.80	.74	.08	.06	112883.542
2. Factor model	715.332*	34	.90	.87	.06	.04	111712.426
3. Bifactor model	228.170*	25	.97	.95	.04	.02	110910.683

Note. N = 5895; χ^2 = chi square goodness of fit statistic; *df* = degrees of freedom; RMSEA = Root-Mean-Square Error of Approximation; AIC = Akaike Information Criterion; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; SRMR = Standardized Square Root Mean Residual. *Indicates χ^2 are statistically significant ($p < .001$).

Table 2
Standardized factor loadings for the general factor (SE) and the two grouping factors of the RSES.

Item	SE	PSE	NSE
SE 1	.696	−.123	
SE 2	.546		.565
SE 3	.617	.173	
SE 4	.529	.168	
SE 5	.648		.136
SE 6	.485		.616
SE 7	.570	.288	
SE 8	.445		.315
SE 9	.541		.248
SE 10	.739	−.229	

Note: all Factor loadings are statistically significant ($p < .001$).

4. Discussion

The present study was carried out in order to provide important empirical evidence regarding the factor structure of the RSES. The uncertainty as to the appropriate factor structure of the RSES is problematic given the frequent use of the RSES in applied research contexts, and it is therefore unsurprising that a large number of researchers have resorted to simply considering a unidimensional scoring scheme when examining the role of self-esteem is a variety of outcomes. Based on the empirical work of Marsh et al. (2010) and the methodological indications of the inappropriateness of including correlated errors in a factorial model (see Bollen, 1989), we investigated the three most relevant model conceptualisations within a large sample of the US adult population.

A seminal study by Marsh et al. (2010) provided important evidence critical to resolving the debate regarding the appropriate factor structure of the RSES. In a longitudinal study performed upon a nationally representative sample of UK adolescent males, clear evidence emerged in support of a bifactor conceptualisation of the structure of the RSES. Specifically, this model included a single general factor of self-esteem and two independent grouping (or method) factors of positive self-esteem and negative self-esteem, each of which account for unique variance in their respective set of items, over and above the variance accounted for by the general factor. Two interesting and relevant findings emerged from this study. The first was that when the researchers investigated the factor structure of the RSES using cross-sectional data, results were ambiguous as to the appropriate factorial representation. However, when examined longitudinally, the bifactor model was found to be the most viable solution, and clear evidence was found of temporal stability within the method factors suggesting that the nature of the wording of the RSES items (positive and negative) represent stable response styles. The second important finding was that the unidimensional conceptualisation did not provide an adequate explanation of RSES responses.

Results of the current study serve to reinforce and extend the findings of Marsh et al. (2010) by supporting the bifactorial solution of the RSES in an adult sample using cross-sectional data. Findings from the current study also undermine the validity of the traditional unidimensional model. Consequently, it can now be strongly argued that such a model is not the most appropriate factorial solution for RSES responses. This is an important finding given that this is the model most frequently used in applied research contexts. As a result, a large proportion of the self-esteem literature may be seriously undermined.

In line with some previous research (e.g., Kaufman et al., 1991), the two-factor structure of the RSES was found to offer an adequate fit of the data. However, the two-factor model was inferior to the bifactor solution. This finding conflicts with the results of work by Boduszek et al. (2013) among adult prisoners which found that the the two-factor model consisting of positive and negative latent variables provided a better fit to their data than the alternative models tested, including a bifactorial conceptualisation. This suggests that although the RSES represents a one-dimensional construct of global self-esteem that is contaminated by method effects in the general population; among a prisoner sample, a two-factor solution is a better representation of RSES responses.

Parameter estimate results from the current study serve to further highlight the necessity to consider PSE and NSE as important method factors when applying the RSES in research contexts. Failing to control for the systematic error variance which arises due to the presence of these two method factors will necessarily give rise to false interpretations regarding the relationship of self-esteem to any other variable, which is evidenced by the poor fit observed for the simple one-factor model. Indeed, failure to take the RSES method factors into account and model them appropriately in previous research may explain the generally weak predictive power of the RSES to explain various outcomes (Baumeister, Campbell, Krueger, & Vohs, 2003). Future research is therefore needed to compare the predictive effect of SE modelled as a unidimensional structure, as is currently standard practice, and the predictive effect of the general SE factor when the two method factors are modelled and controlled for within the bifactorial conceptualisation. Current and past findings (Marsh et al., 2010) suggest that the predictive power of the RSES should increase through the application of a bifactorial conceptualisation.

A significant limitation of the Marsh et al. (2010) investigation was the use of an entirely male sample, thus precluding the possibility of establishing the factorial invariance of the RSES among the sexes. It has been noted that for any measurement instrument it is necessary for the factor structure to be the same, or invariant, for men and women in order to meaningfully test for gender differences (Rock, Werts, & Flaugher, 1978). Therefore, a primary objective of this study was to investigate whether the bifactor solution was invariant between males and females. Consistent with predictions, results indicate that both the structure and the factor loadings of the RSES did not differ between the two groups.

Establishing the appropriate factor structure of any scale is a prerequisite to investigating its reliability given that considering a multidimensional measure as unidimensional can result in unstable estimates of reliability (see Shevlin, Miles, Davies, & Walker, 2000). To more robustly determine the internal consistency of the RSES items, composite reliability was performed rather than traditional methods such as Cronbach's alpha which have been shown to be inappropriate within a latent variable context (Raykov, 1998). The general SE factor was found to possess good internal consistency. The internal reliability of the NSE factor was acceptable, while the PSE was found to possess poor internal consistency. These results serve to further reinforce the supremacy of the general SE factor in the conceptualisation of the RSES.

The current study adds substantially to the existing literature as the bifactor model of the RSES has now been demonstrated to be accurate both cross-sectionally and longitudinally in two large independent samples representing both adolescent and adults populations. Furthermore, current results have provided the first indications of the factorial invariance of the bifactor model among males and females, and have also provided robust evidence of the reliability of such a model conceptualisation. Results of the current study considered in conjunction with those of Marsh et al. (2010) provide strong evidence for the accuracy of a bifactor model of the RSES in the general population and offer a theoretically and methodologically satisfying resolution to much of the debate within the self-esteem literature. Furthermore, current results present an exciting means of furthering and developing the applied self-esteem research field.

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