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The Factor Structure of the Four-Item Perceived Stress Scale in English Adolescents

Ola Demkowicz*, Margarita Panayiotou*, Emma Ashworth*, Neil Humphrey*, and

Jessica Deighton[†]

*Manchester Institute of Education, the University of Manchester, UK

[†]Evidence Based Practice Unit (EBPU), University College London and the Anna Freud

National Centre for Children and Families, UK

Word count: 2,922

Table 1: Descriptive Statistics and PSS-4 Item Frequencies.

Figure 1: Factor Structures for the PSS-4.

Author note

Correspondence concerning this article should be addressed to Ola Demkowicz, Manchester Institute of Education, The University of Manchester, UK. E-mail: ola.demkowicz@manchester.ac.uk

ORCID ID: 0000-0001-9204-0912

Running head: PSS-4 FACTOR STRUCTURE IN ADOLESCENTS

1   Summary

2   This study investigated the factor structure, internal consistency, and known-groups validity

3   of the four-item Perceived Stress Scale in a large sample of 29,388 English adolescents.

4   Results indicated that the original unidimensional structure was not viable and instead

5   provided support for a two-factor structure. Examination of a bifactor-$(S - 1)$ model

6   indicated that this multidimensionality can be attributed to reverse-worded items; however,

7   beyond method effects, these factors appear to capture distinct, though inter-related,

8   constructs. As this multidimensional structure relies on two-item factors, we advise use of

9   longer versions of this measure where possible.

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11   *Keywords:* perceived stress, coping, adolescence, reverse-worded items, bifactor modeling

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26   The Factor Structure of the Four-Item Perceived Stress Scale in English Adolescents

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28   Stress is a salient issue in adolescence, a period encompassing many potentially

29 stressful biological and sociocultural changes (Arnett, 1999). Current perspectives emphasise

30 the need to measure *perceived stress* as appraised by the individual, as opposed to the

31 presence of stressors (Lazarus & Folkman, 1984). Here, we examine the four-item version of

32 the Perceived Stress Scale (PSS) in an adolescent sample. The PSS was developed by Cohen,

33 Kamarck, and Mermelstein (1983) to assess the extent to which individuals appraise their

34 lives as "unpredictable, uncontrollable, and overloading", relative to their ability to cope (p.

35 387).

36   The original PSS-14, comprising seven positively- and seven negatively-worded items,

37 was reported to be a better predictor of health outcomes than objective stressful life-event

38 scales (Cohen et al., 1983) and has been found to be reliable across various populations,

39 including adolescents (e.g., Nguyen-Rodriguez, Chou, Unger, & Spruijt-Metz, 2008; Zhang,

40 Yan, Zhao, & Yuan, 2014). Originally proposed as unidimensional, later validation indicated

41 two factors: *perceived distress* and *perceived coping* (Hewitt, Flett, & Shawn, 1992).

42   Ten-item (PSS-10) and four-item (PSS-4) versions have also been developed

43 (Cohen et al., 1983). The brevity of the PSS-4 makes it attractive for studies with large

44 samples, time limitations, and repeated measurement, but validation remains limited.

45 Evidence suggests mixed findings for internal consistency, with Cronbach's α frequently

46 found to be below the standard .70 threshold (Lee, 2012). The PSS-4 was proposed as

47 unidimensional, but examination of its factor structure is rare and has produced mixed

48 findings, with support for a one-factor (Lesage, Berjot, & Deschamps, 2012; Mitchell, Crane,

49 & Kim, 2008) and two-factor (Leung, Lam, & Chan, 2010) structure, or both in the same

50 sample (González-Ramírez et al., 2013; Wu & Amtmann, 2013). Across all PSS versions,

51   where a two-factor solution is found, it corresponds to groups of positively- and negatively-

52   worded items. This is unsurprising, as reverse-worded items have been shown to interfere

53   with scale reliability and factor structure, potentially creating a multifactorial structure (Wang,

54   Chen, & Jin, 2015).

55   To date, the factor structure of the PSS-4 has not been examined with adolescents and

56   the influence of reverse-worded items on its dimensionality has not been explored. We set

57   out to explore the factor structure, internal consistency, and known-groups validity of this

58   measure in an adolescent sample, with attention to the influence of reverse-worded items.

Method

60   Data were drawn from a major longitudinal research project focused on the mental

61   health and wellbeing of 30,843 young people, attending 114 education settings across six

62   disadvantaged areas of England. Areas were selected in part based on the high proportion of

63   households and neighbourhoods living in deprivation. Education settings across these areas

64   take part in the main research project and pupils complete a number of measures annually to

65   facilitate evaluation.

Sample

67   Participants with missing data on all four PSS items (n = 1,455) were excluded from

68   analysis. The final sample included 29,388 adolescents aged 11–16 (M = 13.31, SD = 1.10).

69   52.2% of participants were female (n = 15,505). Ethnicity reflected the national pattern

70   (Department for Education [DfE] & Office for National Statistics [ONS], 2017); the majority

71   of participants were White (74.2%), followed by Asian (9.6%), Black (5.7%), mixed (3.9%),

72   other/unclassified (2.6%) and Chinese (0.2%). Remaining participants had incomplete data

73   (3.8%). Free school meal eligibility (15.8%) was slightly higher than national levels (14%;

74   DfE & ONS, 2017). 10.8% of participants were identified as having special educational

75   needs, slightly lower than the national average (14.4%; DfE & ONS, 2017).

Measures

PSS-4. Participants rate four items (e.g., "in the last month, how often have you felt that you were unable to control the important things in your life?"; Cohen et al., 1983) on a five-point scale, from 0 to 4 (never, almost never, sometimes, often, and very often, respectively). The second and third items are reverse-scored, and items are summed to create a total score, where a higher score indicates greater perceived stress. Evidence on the internal consistency of PSS has been mixed, with Cronbach's α values often lower than .70 (Lee, 2012). It was shown to have good convergent validity with measures of mental health constructs (Jovanović & Gavrilov-Jerković, 2015; Karam et al., 2012), though this has not been investigated in adolescents.

Strengths and Difficulties Questionnaire (SDQ; emotional problems subscale).
Participants rate five items (e.g., "I worry a lot") on a three-point scale from 0 ("somewhat true") to 2 ("certainly true"), summing a total score of 0–10. Research has shown acceptable psychometric properties for this subscale, demonstrating satisfactory internal consistency and inter-rater reliability (Goodman, Meltzer, & Bailey, 1998). The SDQ can be used as a screening instrument to detect child psychopathology (Goodman et al., 1998). For known-groups analysis, we classified participants scoring 7 or higher as experiencing abnormal levels of emotional problems (SDQ Info, 2016).

Analysis

Confirmatory factor analysis (CFA) was used to explore one-factor (overall perceived stress); two-factor (perceived distress and perceived coping); and bifactor-$(S - 1)$ models (see Figure 1). A bifactor-$(S - 1)$ model specifies a general factor and a specific factor, but with one less specific factor than theorized (Eid, Geiser, Koch, & Heene, 2017). Bifactor-$(S - 1)$ models are less susceptible to anomalous results compared to classic bifactor models (Eid et al., 2017; Heinrich, Zagorscak, Eid, & Knaevelsrud, 2018). The approach allows isolation of

101 method effects and has been used to examine the effects of reverse wording on

102 multidimensionality (Gnambs & Staufenbiel, 2018; Zhang et al., 2016). Models were

103 examined in Mplus 8.2 with weighted least squares means and variance adjusted (WLSMV)

104 estimation to account for the categorical nature of items (Brown, 2015). Type = complex was

105 used to control for data clustering across schools (mean cluster = 257.79; intracluster

106 correlations = .007–.012). Root mean square error of approximation (RMSEA) below .06,

107 standardized root mean squared residual (SRMR) below .08, and comparative fit index (CFI)

108 and Tucker-Lewis index (TLI) values above .95 were considered to indicate acceptable

109 model fit (Hu & Bentler, 1999). For Model 3, latent correlations were fixed to 0 (Eid et al.,

110 2017), and loadings for the specific factor were constrained to equality to allow model

111 identification.

112   Internal consistency was assessed using McDonald's ω and Cronbach's α. The latter

113 was used to allow comparison with the greater literature. Independent t-tests were conducted

114 to assess known-groups validity, or the degree to which the PSS-4 could discriminate

115 between groups with and without abnormal levels of emotional problems, consistent with

116 evidence of an association (e.g., Hewitt et al., 1992).

Results

118   Table 1 presents descriptive statistics, bivariate correlations and item frequencies.

119 Bivariate correlations indicated acceptable values below the .70 threshold for

120 multicollinearity (Tabachnick & Fidell, 2013). No normality violations were identified and

121 floor and ceiling effects were not excessive. Little's (1988) missing completely at random

122 test was significant at the .001 alpha level and missing values for survey items (0.6–2.1%)

123 were assumed missing at random.

124   Figure 1 displays factor loadings and factor correlations. The fit of the one-factor

125 model (Model 1; χ^2 (2) = 2469.70, p < .001; RMSEA = .21, 90% CI [.20, .21], p < .001;

126 SRMR = .08; CFI = .89, TLI = .66) was poor, with large residual correlations (>.10) and

127 inconsistent loadings. The two-factor structure (Model 2) showed acceptable fit: (χ^2 (1) =

128 104.16, p < .001; RMSEA = .06, 90% CI [.05, .07], p = 1.00; SRMR = .01; CFI = 1.00, TLI

129 = .97).

130 The bifactor-(S − 1) model (Model 3) showed the same fit to that of the two-factor

131 model, as these were equivalent. Salient factor loadings (> .40) were observed for items 2

132 and 3 onto the specific method factor, indicating covariance that could be attributed to

133 reverse wording. Items 1 and 4 loaded substantially onto the general factor of perceived

134 stress, while reverse-worded items showed loadings below.40.

135 The internal consistency of the one-factor PSS-4 (α = .62; ω =.63) was lower than the

136 commonly used threshold of .70 (Terwee et al., 2007); item-total reliability coefficients

137 further supported the poor fit of the unidimensional structure. Values for the two-item

138 perceived distress factor were comparatively higher (α = .72; ω =.72), while those for the

139 perceived coping factor were slightly lower (α = .60; ω =.60).

140 Known-groups analysis indicated that participants reporting abnormal levels of

141 emotional symptoms (18.4%; n = 5,408) scored significantly higher on the unidimensional

142 PSS-4 (t (28,101) = 77.66, p < .001, d = 1.19; n = 28,110); on the two-item perceived distress

143 subscale (t (28,591) = 73.69, p <.001, d = 1.11; n = 28,593); and lower on the two-item

144 perceived coping subscale (t (28,621) = 44.68, p < .001, d = 0.69; n = 28,623).

Discussion

146 Results indicate support for a two-factor, rather than unidimensional, structure. The

147 bifactor-(S − 1) model suggests that reverse-worded items could contribute to

148 multidimensionality, with items loading more strongly on the specific factor of "reverse

149 wording effects", relative to the general factor, mirroring previous findings for the PSS-10

150 (Perera et al., 2017). However, it is also feasible that, beyond method effects, these factors

151 capture distinct experiences. The correlation between perceived distress and coping was

152 relatively low ($r = .39$) given that these items could also theoretically represent a singular

153 stress construct. Instead, this finding provides support for the conceptualization of these

154 factors as separate, but inter-related, constructs.

155 Overall, findings provide support for a two-factor structure, though it is unclear the

156 extent to which this is attributable to reverse-wording effects, conceptual differences, or both.

157 Both structures were shown to discriminate well between populations with normal and

158 elevated mental health symptoms; however, the reliance on two-item factors leads us to

159 caution against its use. Conceptually, two items may not fully assess a given construct; it is

160 generally recommended that factors should comprise at least three items (Brown, 2015).

161 Statistically, two-item factors must borrow information from other parts of a model (e.g.,

162 items of other measures) in order to be identified, which can lead to distorted parameters and

163 an inability to assess residual correlations (Muthén, 2009). For clinical usage, two-item

164 subscales likely cannot offer an appropriate level of information to support decision-making

165 (Emons, Sijtsma, & Meijer, 2007). Thus, we advise that researchers and practitioners

166 consider use of longer versions of the PSS in order to gather reliable information.

167 **Limitations**

168 We are cautious in our findings of a two-factor structure given the use of two-item

169 factors, which as noted can be problematic. Additionally, our sample may not be

170 representative, as the main project focused on disadvantaged areas.

Electronic Supplementary Material

ESM 1. Unidimensional CFA output (unidimensional.out)

ESM 2. Two-factor CFA output (twofactor.out)

ESM 3. Bifactor-($S - 1$) CFA output (bifactor.out)

ESM 4. Known-groups validity output (groups.spv)

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Table 1

Descriptive Statistics and PSS-4 Item Frequencies

	M	*SD*	Min–Max	Skewness/ Kurtosis	1	2	3	4
1. PSS-4 total score	6.73	3.17	0-16	.18/-.14	–			
2. PSS-4 perceived distress (items 1 and 4)	3.04	2.14	0-8	.35/-.58	.82***	–		
3. PSS-4 perceived coping (items 2 and 3)[1]	3.69	1.88	0-8	.21/-.29	-.76***	-.25***	–	
4. SDQ emotional problems[2]			0-10		.55***	.53***	-.33***	–

Item frequencies (%)[3] and item-total correlations	Never	Almost never	Sometimes	Fairly often	Very often	Item-total *r*
Item 1: Unable to control the important things	21.8	26	31.4	13.7	7.1	.42
Item 2[R]: Confident about ability to handle personal problems	16.2	28.4	31.0	15.8	8.6	.33
Item 3[R]: Things were going your way	8.1	23.7	40.8	18.1	9.3	.39
Item 4: Difficulties were piling up	28.8	25.3	25.2	13.0	7.8	.47

Note. PSS-4 = four-item Perceived Stress Scale; SDQ = Strengths and Difficulties Questionnaire. [1] Assessment of the perceived coping subscale treats it in its original format rather than using a reversed version. [2]Descriptive and normality statistics are not presented for the SDQ due to its use as a grouping variable rather than a continuous measure. [3] Valid percent frequencies are reported. [R] Items are reverse worded.
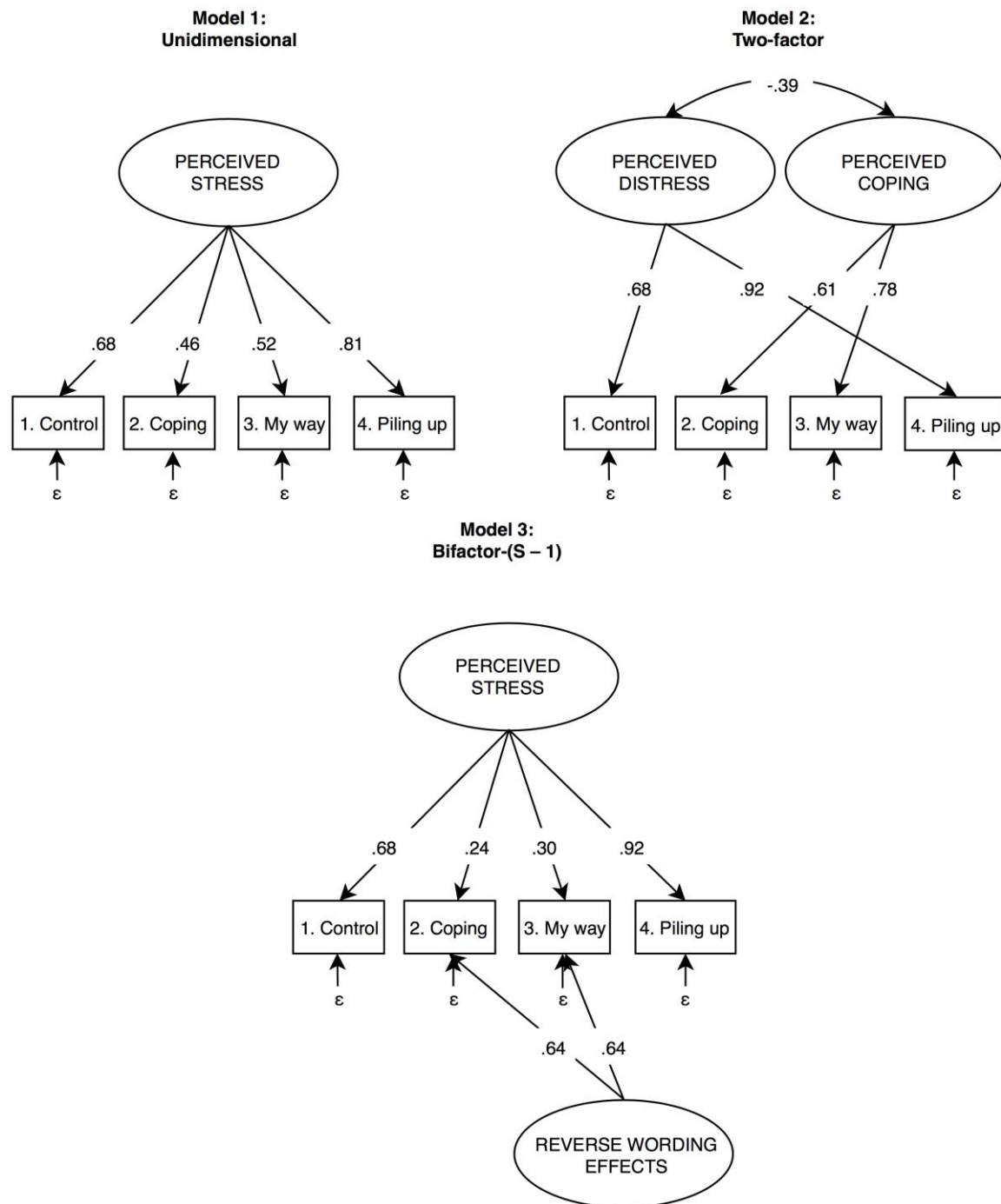
*** $p < .001$.

Figure 1. Factor structures for the PSS-4. All parameter estimates significant at the .001 alpha level.