Measurement invariance of the Distress Tolerance Scale among university students with and without a history of non-suicidal self-injury

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Non-suicidal self-injury (NSSI) is the intentional damage to one's body tissue in the absence of suicidal intent. NSSI primarily serves an emotion regulation function, with individuals engaging in self-injury to escape intense or unwanted emotion. Low distress tolerance has been identified as a mechanism that underlies self-injury, and is commonly assessed using the self-report Distress Tolerance Scale. There are mixed findings regarding the factor structure of the Distress Tolerance Scale, with some researchers utilising a higher-order distress tolerance score (derived from the scores on the four lower-order subscales) and other researchers using the four subscales as unique predictors of psychological outcomes. Neither of these factor structures have been assessed among individuals with a history of self-injury. Of note, an inability to tolerate distress (thought to underlie NSSI) may limit an individual's capacity to accurately observe and report specific thoughts and emotions experienced in a state of heightened distress, which may impact the validity of scores on the Distress Tolerance Scale. Therefore, measurement invariance should be established before attributing NSSI-related differences on the scale to true differences in distress tolerance. We compared the Distress Tolerance Scale higher-order model with the lower-order four factor model among university students with and without a history of NSSI. Our results indicated that the lower-order four factor model was a significantly better fit to the data than the higher-order model. We then tested the measurement invariance of this lower-order factor model among individuals with and without a history of NSSI, and established configural and full metric invariance, followed by partial scalar and full residual error invariance. These results suggest the four subscales of the Distress Tolerance Scale can be used to confidently discern NSSI-related differences in distress tolerance.

1   RUNNING HEAD: Measurement invariance of the Distress Tolerance Scale

3   Measurement Invariance of the Distress Tolerance Scale among University Students With
4   and Without a History of Non-Suicidal Self-Injury

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32   **Abstract**

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34   Non-suicidal self-injury (NSSI) is the intentional damage to one's body tissue in the absence of

35   suicidal intent. NSSI primarily serves an emotion regulation function, with individuals engaging

36   in self-injury to escape intense or unwanted emotion. Low distress tolerance has been identified

37   as a mechanism that underlies self-injury, and is commonly assessed using the self-report

38   Distress Tolerance Scale. There are mixed findings regarding the factor structure of the Distress

39   Tolerance Scale, with some researchers utilising a higher-order distress tolerance score (derived

40   from the scores on the four lower-order subscales) and other researchers using the four subscales

41   as unique predictors of psychological outcomes. Neither of these factor structures have been

42   assessed among individuals with a history of self-injury. Of note, an inability to tolerate distress

43   (thought to underlie NSSI) may limit an individual's capacity to accurately observe and report

44   specific thoughts and emotions experienced in a state of heightened distress, which may impact

45   the validity of scores on the Distress Tolerance Scale. Therefore, measurement invariance should

46   be established before attributing NSSI-related differences on the scale to true differences in

47   distress tolerance. We compared the Distress Tolerance Scale higher-order model with the lower-

48   order four factor model among university students with and without a history of NSSI. Our

49   results indicated that the lower-order four factor model was a significantly better fit to the data

50   than the higher-order model. We then tested the measurement invariance of this lower-order

51   factor model among individuals with and without a history of NSSI, and established configural

52   and full metric invariance, followed by partial scalar and full residual error invariance. These

53   results suggest the four subscales of the Distress Tolerance Scale can be used to confidently

54   discern NSSI-related differences in distress tolerance.

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68 Non-suicidal self-injury (NSSI) is the intentional damage to one's body tissue in the absence of
69 suicidal intent, for reasons not socially or culturally sanctioned (International Society for the
70 Study of Self-Injury, 2018). International prevalence rates indicate approximately 13.4% of
71 young adults report a history of self-injury, with elevated rates (20%) reported by university
72 students (Swannell, Martin, Page, Hasking, & St John, 2014). NSSI is a behaviour receiving
73 increasing attention from both researchers and clinicians, given its associations with negative
74 psychological outcomes and heightened risk of suicide over time (Whitlock et al., 2013). Whilst
75 there are various reasons for engaging in NSSI, individuals primarily report engaging in self-
76 injury for emotion regulation purposes (Taylor et al., 2018). Several key theoretical models of
77 NSSI, including the Emotional Cascade Model (Selby, Anestis, & Joiner, 2008), the Experiential
78 Avoidance Model (Chapman, Gratz, & Brown, 2006) and the Cognitive-Emotional Model
79 (Hasking, Whitlock, Voon, & Rose, 2017), specify a central role for emotion regulation in the
80 onset and maintenance of self-injury. According to these models and previous empirical
81 research, heightened negative affect (Armey, Crowther, & Miller, 2011; Boyes, Wilmot, &
82 Hasking, 2019; Najmi, Wegner, & Nock, 2007; Slabbert, Hasking, Notebaert, & Boyes, 2020),
83 low positive affect (Bresin, 2014; Slabbert et al., 2020; Victor & Klonsky, 2014), greater
84 repetitive negative thinking (Gong et al., 2019; Slabbert, Hasking, & Boyes, 2018b), as well as
85 greater difficulties in emotion regulation (Gratz, Breetz, & Tull, 2010; Jenkins & Schmitz, 2012)
86 are all associated with increased likelihood of engaging in NSSI. Also common to these models
87 is one's ability to tolerate distress arising from emotional experiences.

88 Distress tolerance refers to both an individual's perceived and actual ability to tolerate aversive
89 physical and emotional states (Leyro, Zvolensky, & Bernstein, 2010). Theoretically, individuals
90 who experience greater difficulties tolerating intense emotion are less willing (or able) to
91 withstand distress and more likely to self-injure as a means of escaping the aversive emotional
92 state (Chapman et al., 2006). Researchers have established direct links between low distress
93 tolerance and NSSI; individuals with lower levels of distress tolerance are more likely to report
94 a history of self-injury (Anestis, Knorr, Tull, Lavender, & Gratz, 2013; Lin, You, Wu, & Jiang,
95 2018; Slabbert, Hasking, & Boyes, 2018a) as well as more frequent NSSI (Anestis et al., 2013).
96 Distress tolerance is typically assessed with self-report measures, most commonly the Distress
97 Tolerance Scale (Simons & Gaher, 2005).

98 The Distress Tolerance Scale (Simons & Gaher, 2005) is a multidimensional scale designed to
99 capture four core facets of distress tolerance; an individual's perceived ability to tolerate
100 emotional distress (tolerance), subjective appraisal of distress regarding whether the distress is
101 seen as acceptable or shameful (appraisal), the level of attention absorbed by distressing
102 emotions (absorption), and efforts taken to alleviate the distress (regulation). A higher-order
103 global distress tolerance score is derived by averaging the scores on the four subscales. The
104 internal consistency of the higher-order scale and lower-order scales is generally good, with
105 convergent and divergent validity previously established (Leyro, Bernstein, Vujanovic, McLeish,
106 & Zvolensky, 2010; Simons & Gaher, 2005).

107 There is evidence to support the higher-order factor structure (Leyro, Bernstein, et al., 2010;
108 Sandín, Simons, Valiente, Simons, & Chorot, 2017; Werner-Seidler, Banks, Dunn, & Moulds,

109   2013), and many researchers opt to only utilise the total distress tolerance score in their research
110   (Anestis et al., 2013; Hovrud, Simons, Simons, & Korkow, 2019; Peterson, Davis-Becker, &
111   Fischer, 2014). However, there is growing acknowledgment that the tendency to only focus on
112   global distress tolerance has resulted in researchers losing potentially important information
113   captured in the individual subscales that may better explain relationships between distress
114   tolerance and psychopathology, or behaviours such as NSSI (Leyro, Bernstein, et al., 2010). In
115   studies where researchers have elected to investigate the four subscale scores, findings indicate
116   that some subscales may be more salient than others in predicting psychopathology such as
117   anxiety and depression, as well as dysregulated behaviours including self-injury (Horgan &
118   Martin, 2016; Lin et al., 2018).

119   The two different factor structures have only been directly compared in one study. Among a
120   sample of Chinese adolescents, You and Leung (2012) found both the higher-order factor model
121   and lower-order four factor model demonstrated better fit than 1-factor and 2-factor structures
122   with which they were compared, with the higher-order model demonstrating best fit. Despite
123   You and Leung's (2012) findings, there is some evidence to suggest lower-order factor models
124   may demonstrate better model fit than higher-order models (Meganck, Vanheule, & Desmet,
125   2008). Therefore, it is necessary to evaluate the fit of each of these models among individuals
126   with a history of NSSI to further our theoretical understanding of the nature of the relationship
127   between distress tolerance and self-injury, and consequently inform researchers about the
128   optimal way to utilise this scale with samples of individuals with a history of NSSI.

129   Another growing concern regarding the measurement of constructs such as distress tolerance, is
130   the accuracy of the heavily relied upon self-report scales such as the Distress Tolerance Scale to
131   detect true group differences. Researchers have become increasingly aware that statistically
132   observed differences on these scales are only meaningful when these instruments demonstrate
133   invariance across groups (Sass, 2016). Measurement noninvariance may have several
134   problematic implications. For example, using non-invariant scales to assess the severity of
135   psychological disorders such as depression across groups (i.e. women and men) may result in
136   one group (i.e. men) scoring lower than the other, simply because they interpret the items
137   differently, as opposed to actually experiencing less severe depression (Putnick & Bornstein,
138   2016). Consequently, our understanding based on these findings is that females experience more
139   severe depression than men which may not be accurate, but directs future research towards
140   female-oriented studies and interventions (Putnick & Bornstein, 2016). Relatedly, another
141   example of where measurement invariance is problematic is the use of pre-test and post-test
142   measurements to assess the effectiveness of an intervention or clinical trial. It is possible that the
143   intervention or trial itself may impact how participants interpret the constructs being assessed
144   (Putnick & Bornstein, 2016). Consequently, this may result in inaccurate conclusions regarding
145   the effectiveness of an intervention (Putnick & Bornstein, 2016). These example highlight the
146   importance of establishing measurement invariance in psychological science.

147   Recent research testing the measurement invariance of three emotion regulation questionnaires in
148   young adults with and without a history of NSSI showed that observed NSSI-related differences
149   on the Difficulties in Emotion Regulation Scale – Short Form (DERS-SF; Gratz & Roemer,

150   2004) and the Cognitive Emotion Regulation Questionnaire – Short (CERQ-S; Garnefski &
151   Kraaij, 2007) were reliable and likely a true reflection of group differences in emotion regulation
152   (Kiekens, Hasking, & Boyes, 2019). However, the widely used Emotion Regulation
153   Questionnaire (ERQ; Gross & John, 2003) did not demonstrate measurement invariance, with
154   two of the items on the Cognitive Reappraisal subscale functioning differently for individuals
155   with a history of self-injury compared to individuals who had never self-injured. This is
156   concerning as previous research that has established NSSI-related differences in cognitive
157   reappraisal using this scale may be reflecting a measurement artefact rather than true group
158   differences. Similarly, Greene et al (2020) established that the Externally Oriented Thinking
159   subscale of the frequently used Toronto Alexithymia Scale (TAS-20; Bagby, Taylor, Parker, &
160   Dickens, 2006) was not invariant across individuals with and without a history of NSSI,
161   precluding any conclusions regarding NSSI-related differences in externally oriented thinking.
162   These findings highlight the importance of investigating the measurement invariance of self-
163   report measures to reveal whether or not we can reliably draw conclusions about particular group
164   differences using these assessment tools.

165   Measurement invariance of the Distress Tolerance Scale between individuals with and without a
166   history of NSSI has not yet been assessed. It is plausible that the very difficulties in withstanding
167   distress underlying dysregulated behaviours such as NSSI, may limit an individual's capacity to
168   accurately observe and report specific thoughts and emotions experienced in a heightened
169   distressed state, which may impact the validity of results on self-report measures such as the
170   Distress Tolerance Scale. Observed differences in distress tolerance between people who do and
171   do not self-injure may be a function of a differential interpretation of scale items, rather than a
172   reflection of true group differences in distress tolerance. Given results derived from these
173   measures are used by researchers and clinicians to inform future prevention and intervention
174   programs, it is vital that we ensure these instruments are able to accurately produce reliable
175   results across individuals with and without a history of self-injury. Additionally, this may have
176   implications for the existing body of literature that has established NSSI-related differences in
177   self-report distress tolerance using this scale, and future researchers may need to be cautious
178   when using these findings to justify their aims or results.

179   This study had two primary aims. First, to test and compare the higher-order model of the
180   Distress Tolerance Scale to the lower-order four factor model to determine the best fitting model
181   among a sample of university students, as well as within subgroups of individuals with and
182   without a history of NSSI. Second, to test measurement invariance of the best fitting model
183   between individuals with and without a history of self-injury.

184   **Materials and Methods**

185   **Participants and procedure.**

186   *Total Sample.* Participants were 531 Australian University students (74.7% female) between the
187   ages of 17 and 25 (M = 20.58, SD = 1.94) recruited through an undergraduate participant pool
188   and social media platforms. Of participants, 412 (77.6%) were born in Australia, followed by
189   India (2.6%), and Malaysia (2.3%). The majority of participants were currently completing an

190 undergraduate bachelor degree (96%), followed by a Master degree (2.4%). In total, 171 (32.2%)
191 of individuals reported a history of mental illness, most commonly anxiety and depression.

192 *History of NSSI.* Of the total sample, 215 individuals who reported a prior history of NSSI (M_{age}
193 = 20.87, SD = 2.0). Of these, 188 (87.4%) were female, 173 (80.5%) were born in Australia, and
194 202 (94%) were studying an undergraduate bachelor degree. With regards to mental illness, 127
195 (59.1%) participants reported a history of mental illness, most commonly anxiety and depression.

196 *No history of NSSI.* Of the total sample, 316 participants reported never engaging in NSSI (M_{age}
197 = 20.38, SD = 1.88). Of these, 209 were female (66.1%), 239 (75.6%) were born in Australia,
198 and 308 (97.5%) were studying an undergraduate bachelor degree. With regards to mental
199 illness, 44 (13.9%) participants reported a history of mental illness, again most commonly
200 anxiety and depression.

201 After providing informed consent, participants completed a series of online questionnaires hosted
202 by Qualtrics. Data were collected as part of a larger study investigating the role of social,
203 cognitive, and emotional factors underlying health risk behaviours. Students received either
204 course credit or were entered into a prize draw to win an iPad or $50 gift cards. This study
205 received ethical approval from the Curtin University Human Research Ethics Committee and
206 participants were provided with a list of counselling resources and information about self-injury
207 upon completion of the survey.

208 **Measures.**

209 *Distress Tolerance.* The 15-item Distress Tolerance Scale (Simons & Gaher, 2005) was used to
210 assess individual differences in the ability to experience and withstand negative psychological
211 states. Items are rated on a 5-point Likert scale (1: strongly agree; 5: strongly disagree), with
212 higher scores reflecting higher levels of distress tolerance. The scale consists of four subscales:
213 tolerance (3 items, e.g. "I can't handle feeling distressed or upset"), appraisal (6 items, e.g. "My
214 feelings of distress or being upset are not acceptable"), absorption (3 items, e.g. "My feelings of
215 distress are so intense that they completely take over", and regulation (3 items, e.g. "I'll do
216 anything to avoid feeling distressed or upset"). Subscale scores are calculated by averaging
217 response to all items on each subscale. A higher-order distress tolerance score is calculated by
218 averaging the subscale mean scores. This scale demonstrates excellent internal consistency (α =
219 0.89; Simons and Gaher, 2005; Peterson et al., 2014). Internal consistencies were adequate to
220 excellent in the current sample (Global Score, α = 0.93, ω = 0.93; Tolerance, α = 0.84, ω = 0.85;
221 Appraisal, α = 0.85, ω = .0.86; Absorption α = 0.86, ω = 0.86; Regulation, α = 0.76, ω = 0.79).

222 *Non-suicidal self-injury.* Section I of the Inventory of Statements About Self-Injury (ISAS;
223 Klonsky & Glenn, 2009) was used to assess history and frequency of NSSI (defined to
224 participants as intentionally harming oneself without intention to suicide). Individuals were first
225 provided with a definition of NSSI and then asked "Have you ever engaged in non-suicidal self-
226 injury?". Participant who responded yes to this question were then asked to report a lifetime
227 frequency of twelve common methods of NSSI (e.g. cutting, scratching, burning). The ISAS
228 demonstrates good four week test-retest reliability, (r = .85; Klonsky & Olino, 2008).

Data analysis

To determine the best fitting model, we examined the model fit of the original higher-order factor structure and the lower-order four factor structure of the Distress Tolerance Scale using a sequence of Confirmatory Factor Analyses with a Maximum Likelihood Estimation with robust standard errors and a mean- and variance adjusted test statistic (MLMV). These analyses were conducted among the total sample, the sub-sample of individuals with a history of NSSI, and the sub-sample of individuals without a history of NSSI. A model demonstrated acceptable fit if it met the following criteria: Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) values between 0.90 (adequate) and 0.95 (good) or higher, and a Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) values close to or below 0.08 (Brown, 2015). Modification indices suggested residual variances be correlated to improve model fit. Given there was a cluster of items with error covariances above .40 on the same subscale, we had theoretical justification for allowing these items to correlate in order to improve model fit (Whittaker, 2012). A chi-square difference test was conducted to statistically compare the two models.

We then tested for measurement invariance across individuals with and without a history of NSSI using the best-fitting model using a multigroup confirmatory factor analysis (MGCFA) with Maximum Likelihood Estimation with robust standard errors and a mean- and variance adjusted test statistic (MLMV). We assessed configural (i.e., equal pattern of factor loadings), metric (i.e., equal factor loadings), scalar (i.e., equal factor loadings and equal intercepts), and residual error invariance (i.e., equal factor loadings, equal intercepts, and equal residual error variance uniqueness). Measurement invariance was supported if the configural model demonstrated acceptable fit and each of the subsequent models showed a non-significant change in chi-square test statistic and a change in Comparative Fit Index (CFI) of < 0.01 and in Root Mean Square Error of Approximation (RMSEA) of < 0.015 and Standardized Root Mean Square Residual (SRMR) of < 0.030 (for metric invariance) or < 0.015 (for scalar or residual invariance; Chen, 2007) from the previous levels. Partial invariance will be addressed using a sequential backwards approach where items are freed until partial invariance is achieved (Putnick, 2016). All analyses were conducted using MPlus v7.4 (Muthén & Muthén, 2012)[1].

Results

Results from a Missing Values Analysis indicated data were missing not completely at random, $\chi2(4012) = 4204.185$, $p = .02$, however given less than 5% of data were missing on all variables, Expectation Maximization was used to impute missing data (Tabachnick & Fidell, 2013). Of the 531 participants, 215 (40.5%) reported a history of NSSI, with 118 (54.9%) of these individuals reporting engaging in self-injury in the past 12 months. The primary method of NSSI was cutting (50%), followed by severe scratching (12.4%), and self-battery (11.4%). Age of onset ranged from 4 to 23 years ($M = 13.69$, $SD = 2.99$). Descriptive statistics are presented in Table 1.

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[1] Given the majority of participants were female, and at the request of an anonymous reviewer, we also tested measurement invariance across gender. Results indicated that configural, metric, scalar, and residual error invariance across gender were all supported, and thus we conclude males and females do not respond differently to items on this scale (see Supplementary Table 2).

266 **(Table 1 approximately here)**

267 **Factor structure evaluation.** Both the original higher-order model and the lower-order four
268 factor model demonstrated adequate baseline fit in the total sample and among individuals
269 without a history of NSSI, but demonstrated poorer fit among individuals with a history of NSSI
270 (Table 2). Given item 7 "My feelings of distress or being upset are not acceptable", and 11 "I am
271 ashamed of myself when I feel distressed or upset" were both on the appraisal subscale and had
272 error covariance larger than 0.40, these two items were allowed to correlate. Item 11 and 12 "My
273 feelings of distress or being upset scare me" were also on the appraisal subscale and had error
274 variance larger than 0.40 so were allowed to correlate.

275 Results from chi-square difference tests indicate allowing these items to correlate significantly
276 improved the baseline fit of the higher-order model in the total sample $\Delta\chi^2(2) = 75.561$, p < .001,
277 within the sub-sample of individuals with a history of NSSI $\Delta\chi^2(2) = 24.355$, p < .001, and
278 within the sub-sample of individuals without a history of NSSI $\Delta\chi^2(2) = 47.708$, p < .001.
279 Despite this improvement, the higher-order model still remained a poor fit among individuals
280 with a history of NSSI (Table 2).
281
282 Comparatively, these modifications resulted in the lower-order four factor model demonstrating
283 good fit within the total sample $\Delta\chi^2(2) = 67.501$, p < .001, and among individuals without a
284 history of NSSI $\Delta\chi^2(2) = 43.334$, p < .001, and adequate fit among individuals with a history of
285 NSSI, $\Delta\chi^2(2) = 21.971$, p < .001. Importantly, chi-square difference tests indicated the lower-
286 order four factor model was a significantly better fit than the higher-order model in all three
287 groups (Table 2). The factor loadings (full sample) for both the higher-order and lower-order
288 factor models are illustrated in Figure 1 and Figure 2.
289
290 **(Insert Table 2, Figure 1, and Figure 2 approximately here)**

291 **Measurement invariance of the DTS lower order 4 factor model**. Given the correlated lower-
292 order four factor model was the best fit, this is the model we chose to evaluate for measurement
293 invariance. Configural (M1) and full metric (M2) invariance was supported for the lower-order
294 four factor model, but the $\Delta\chi^2$ test statistic indicated full scalar (M3.1) invariance was not
295 supported (Table 3). To address achieve partial invariance, we identified the source of non-
296 invariance by sequentially releasing item intercept constraints until the model was invariant
297 (Putnick et al., 2016). We identified that releasing item 10 intercept constraints had the most
298 influential impact on model fit. Irrespective of the score on the underlying latent factor appraisal,
299 there was a tendency for young adults who self-injured to agree more with item 10 "Being
300 distressed or upset is always a major ordeal for me" (Intercept$_{(No\ NSSI)}$ = 3.31 vs. Intercept$_{(NSSI)}$ =
301 2.56). Allowing these intercepts to vary between groups, partial scalar (M3.2) and full residual
302 error (M4) invariance was supported.

303 **(Insert Table 3 approximately here)**

304 There were significant latent mean differences, with individuals with a history of NSSI scoring
305 lower than those with no history on the tolerance subscale (Z = -7.92, p < .001), absorption
306 subscale (Z = -10.20, p < .001), and regulation subscale (Z = -4.52, p < .001). Regardless of
307 whether the differential item functioning of item 10 on the appraisal subscale was considered (Z

308   = -8.08, *p* < .001), or ignored (*Z* = -7.68, *p* < .001), individuals with a history of NSSI scored
309   lower than individuals without a history of NSSI.

Discussion

311   Many studies use the self-report Distress Tolerance Scale to examine group differences in
312   distress tolerance between individuals with and without a history of self-injury (Anestis et al.,
313   2013; Horgan & Martin, 2016; Lin et al., 2018; Slabbert et al., 2018a). Relative to individuals
314   with no history of self-injury, individuals with a history of NSSI report less global distress
315   tolerance (Anestis et al., 2013; Lin et al., 2018; Slabbert et al., 2018a), with group differences
316   specifically observed on the appraisal and absorption subscales (Horgan & Martin, 2016;
317   Slabbert, Hasking, Greene, & Boyes, in press). However, to ensure confidence in these findings
318   it is important that we confirm the psychometric properties, including measurement invariance,
319   of the Distress Tolerance Scale among individuals with and without a history of self-injury. The
320   aim of the current study was to compare the higher-order and the lower-order four factor
321   structure of the scale among a sample of university students, as well as within the sub-samples of
322   individuals with and without a history of NSSI, to determine the best fitting model, and whether
323   this was invariant across individuals with and without a history of NSSI.

324   Results indicated that the lower-order four factor structure demonstrated superior fit in all
325   analyses. Based on these findings, measurement invariance analyses were conducted on the
326   lower-order four factor model, with results indicating full invariance at the configural and metric
327   level, followed by partial scalar and full residual error invariance. Despite freeing one item
328   intercept at the scalar level, observation of latent mean differences indicate that all subscales can
329   be confidently used to assess NSSI-related group differences in distress tolerance.

330   The findings suggest that using the four subscales of the Distress Tolerance Scale including
331   Tolerance, Appraisal, Absorption, and Regulation, as unique predictors of outcomes such as
332   NSSI, as opposed to a single distress tolerance score, may be statistically superior. It is not
333   uncommon for lower-order factor models to demonstrate better fit than when the lower-order
334   factors are forced to load onto a higher-order factor, with similar results evident in self-report
335   measurement of alexithymia (Meganck et al., 2008). However, it is important to acknowledge
336   that the difference between these two models, although significant, was not large. With some
337   minor modifications, the higher-order factor model still demonstrated adequate fit in the full
338   sample and among individuals with no history of self-injury. This higher-order model may prove
339   useful in research contexts where a global distress tolerance score is valuable, perhaps in studies
340   where researchers are interested in a broad range of constructs and require a more simplistic and
341   direct way of assessing distress tolerance.

342   However, the use of the individual subscales may provide a more comprehensive and holistic
343   understanding of key elements underlying distress tolerance and its relationship with
344   psychopathology and behaviours such as NSSI. For example, in one of the few studies that
345   examined associations between the four distress tolerance subscales and NSSI, Horgan and
346   Martin (2009) established that only the appraisal and absorption subscales differentiated people
347   with and without a history of self-injury. Similarly, Slabbert et al (in press) found that the

348   appraisal and absorption scales differentiated between individuals who had recently self-injured
349   and individuals who had never self-injured. Their results also indicated that experiencing greater
350   positive affect might protect against negative appraisals of distress. Based on these findings, how
351   one views their distress and how much attention they allocate towards this distress, appear to be
352   more important in predicting NSSI than an individual's perception of the their tolerance or how
353   they attempt to regulate their distress. Employing this four factor model in future research will
354   allows researchers to delve deeper into the relationship between distress tolerance and self-injury
355   and consequently gain a more accurate and nuanced understanding regarding how different
356   aspects of distress tolerance are related to NSSI.

357   After establishing that the lower-order four factor model was the superior fitting model, we
358   investigated whether it was invariant among individuals with and without a history of NSSI. Our
359   results were promising, with full configural and metric invariance being supported, and after
360   freeing the item intercept for one item ("Being distressed or upset is always a major deal for
361   me"), partial scalar invariance was achieved. Consequently, full residual error invariance was
362   satisfied however this was contingent on the partial scalar model where the intercept constraints
363   for item 10 were released. When examining this item, it does not appear to differ in terms of its
364   content in comparison to other items, such that it fits well within the general concept of
365   perceived tolerance of distress tolerance. If it appeared to assess something more abstract or
366   obscure in comparison to the other items this may explain differences in interpretation however
367   this does not appear to be the case. Another factor thought to impact interpretation of items is
368   whether they are positively or negatively keyed (Meganck et al., 2008). Previous research has
369   established noninvariance between groups on negatively keyed items (Lindwall et al., 2012),
370   however once again this is not the case with regards to item 10 on the Distress Tolerance Scale
371   as it is positively keyed. Therefore it is not clear why individuals with a history of NSSI may
372   have a different interpretation of this item compared to individuals who have never self-injured.
373   However, the strictest test of invariance was employed in this analysis (chi-square difference
374   test). If we had employed the more liberal criteria used to assess measurement invariance which
375   supports invariance if the difference in CFI between the configural level and other levels is less
376   than 0.01 (Chen, 2007) then full scalar invariance would have been achieved. Regardless,
377   whether this item intercept was freed or not, there were still significant mean differences on the
378   appraisal subscale with individuals with a history of NSSI tending to appraise their distress as
379   more unacceptable than individuals with no history of NSSI. These results instil confidence that
380   we are able to reliably detect real group differences in distress tolerance between individuals
381   with and without a history of NSSI using this four-factor Distress Tolerance Scale.

382   Whilst the findings of this study provide promising support for the use of the Distress Tolerance
383   Scale to examine NSSI-related group differences in distress tolerance, there are several
384   limitations that warrant consideration. The sample predominantly comprised female university
385   students who self-selected into the study, meaning these findings may not generalise to a
386   community sample. Additionally, while NSSI is prevalent amongst university students, it is
387   unlikely that many would meet the diagnostic criteria for the proposed NSSI disorder (Keikens et
388   al., 2018). Individuals who meet this criteria would likely experience significantly greater
389   difficulties in emotion regulation and consequently may also have more difficulty reflecting on

390   previous times of heightened distress and reporting on their ability to tolerate distress. Therefore,
391   investigation of measurement invariance of the Distress Tolerance Scale in clinical samples is
392   warranted.

393   **Conclusion**

394   In evaluating the two models of the Distress Tolerance Scale, as well as testing the measurement
395   invariance of the lower-order four factor model, this study has provided support for the use of
396   this scale to reliably assess NSSI-related group differences. The lower-order four factor model
397   appears to be statistically superior and may offer a more comprehensive understanding of the
398   relationship between the specific facets of distress tolerance and behaviours such as NSSI.
399   Additionally, the lower-order four factor model demonstrated invariance up until the scalar level
400   according to the strictest invariance criteria, requiring only one item intercept to be freed to
401   satisfy partial and full residual error invariance. Although further investigation in other samples
402   is required, these results suggest that the Distress Tolerance Scale can be used with confidence
403   that true group differences will be reflected in scores.

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531

Descriptive statistics disaggregated by history of NSSI

Table 1

Descriptive statistics disaggregated by history of NSSI

	Total Sample			No history of NSSI ($n = 316$)			History of NSSI (n =215)			t^a
	M (SD)	Skewness (SD)	Kurtosis (SD)	M (SD)	Skewness (SD)	Kurtosis (SD)	M (SD)	Skewness (SD)	Kurtosis (SD)	
Tolerance	2.94 (1.07)	.11 (.11)	-.64 (.21)	3.22 (1.01)	.04 (.14)	-.66 (.27)	2.53 (1.01)	.31 (.17)	-.48 (.33)	7.70***
Appraisal	3.09 (.94)	.03 (.11)	-.61 (.21)	3.42 (.84)	.02 (.14)	-.62 (.27)	2.59 (.87)	.29 (.17)	-.52 (.33)	11.00***
Absorption	2.81 (1.10)	.18 (.11)	-.76 (.21)	3.18 (1.01)	.02 (.14)	-.67 (.27)	2.25 (.98)	.56 (.17)	-.37 (.33)	10.63***
Regulation	2.90 (.92)	.11 (.11)	-.27 (.21)	3.03 (.89)	.16 (.14)	-.11 (.27)	2.70 (.94)	.14 (.17)	-.50 (.33)	4.12***
Total DTS score	2.93 (.85)	.07 (.11)	-.35 (.21)	3.22 (.79)	.04 (.14)	-.29 (.27)	2.52 (.77)	.13 (.17)	-.42 (.33)	10.14***

[a] t values are in reference to the mean comparison between individuals with and without a history of NSSI.

*p<.05. ** p<.01. *** p<.001.

Comparison of DTS models among the total sample, individuals with a history of NSSI, and individuals without a history of NSSI

Table 2

Comparison of DTS models among the total sample, individuals with a history of NSSI, and individuals without a history of NSSI

	χ^2	df	$\Delta \chi^2 (\Delta df)$	$p \Delta \chi^2$	CFI	TLI	RMSEA	SRMR
Total sample (*n* = 531)								
Baseline fit								
Higher-order factor model	356.534	86	-	-	0.915	0.896	0.077	0.059
Lower-order factor model	312.991	82	43.543(2)	< 0.001	0.928	0.910	0.072	0.051
Baseline fit with appraisal item correlations								
Higher-order factor model	280.973	84	-	-	0.938	0.923	0.066	0.055
Lower-order factor model	245.490	82	35.483(2)	< 0.001	0.949	0.934	0.061	.047
NSSI history (*n* = 215)								
Baseline fit								
Higher-order factor model	210.779	86	-		0.872	0.844	0.082	0.087
Lower-order factor model	181.950	84	28.829(2)	< 0.001	0.899	0.874	0.074	0.071
Baseline fit with appraisal item correlations								
Higher-order factor model	186.424	84	-	-	0.895	0.869	0.075	0.084
Lower-order factor model	159.979	82	26.45 (2)	< 0.001	0.920	0.897	0.067	0.067
No NSSI history (*n* = 316)								
Baseline fit								
Higher-order factor model	200.891	86	-		0.923	0.906	0.065	0.053
Lower-order factor model	188.532	84	12.359(2)	0.002	0.930	0.913	0.063	0.051
Baseline fit with appraisal item correlations								
Higher-order factor model	153.183	84	-	-	0.954	0.942	0.051	0.049
Lower-order factor model	145.198	82	7.99 (2)	0.018	0.958	0.946	0.049	0.045

Measurement invariance of the lower-order four factor Distress Tolerance Scale

Table 3

Measurement invariance of the lower-order four factor Distress Tolerance Scale

	χ^2	*df*	$\Delta \chi^2 (\Delta$ df)	*p* $\Delta \chi^2$	NCI	CFI	RMSEA	SRMR	Model Comparison	ΔNCI	ΔCFI	ΔRMSEA	ΔSRMR
Model 1: Configural invariance	304.965	164	-	-	0.8755	0.943	0.057	0.055	-	-	-	-	-
Model 2: Full metric invariance	315.623	175	10.66 (11)	0.472	0.8758	0.943	0.055	0.058	M1-M2	0.0003	<0.001	0.002	0.003
Model 3.1: Full scalar invariance	338.147	186	22.52 (11)	0.021	0.8663	0.939	0.056	0.063	M2-M3.1	0.0100	0.004	0.001	0.005
Model 3.2: Partial scalar invariance[a]	328.614	185	12.99 (10)	0.224	0.8733	0.942	0.054	0.060	M2-M3.2	0.0035	0.001	0.001	0.002
Model 4: Full residual error invariance	348.770	200	20.16 (15)	0.166	0.8691	0.940	0.053	0.062	M3.2-M4	0.0042	0.002	0.001	0.002

Figure 1

Distress Tolerance Scale Higher-Order Factor Model (Total Sample)
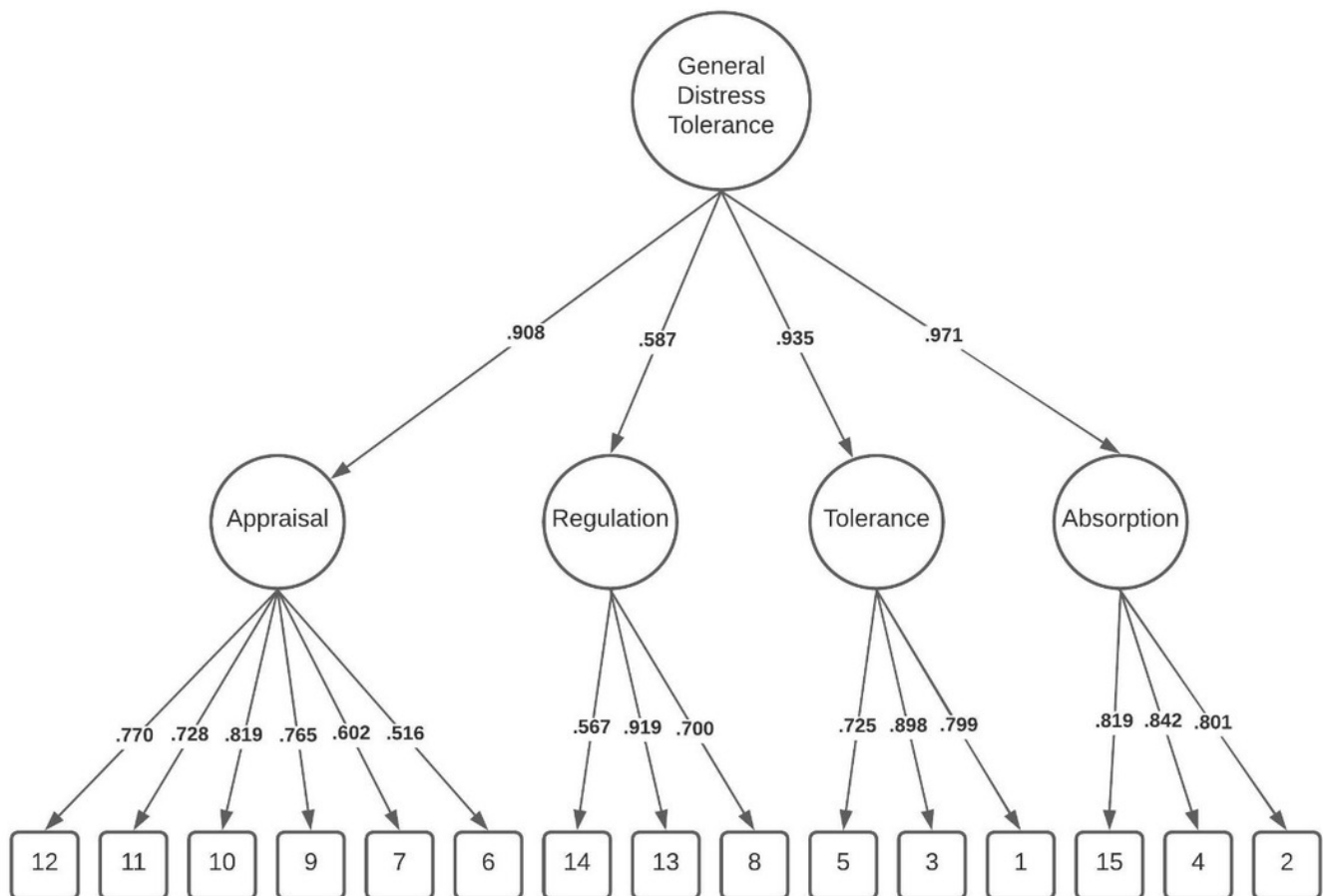
Figure 2

Distress Tolerance Scale Lower-Order Four Factor Model (Total Sample)