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# Assessing Mechanisms of Mindfulness: Improving the Precision of the Nonattachment Scale Using a Rasch Model

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**Abstract** Nonattachment, or the lack of possessive and mental fixations and clinging, is considered a key element by which mindfulness cultivates psychological wellbeing. The 30-item Nonattachment Scale (NAS) is a measure of nonattachment, but its item functioning and measurement precision remain to be explored. The present study used a Rasch model to examine 434 participants' responses to the NAS. Disordered thresholds were corrected by uniform item re-scoring. Satisfactory model fit was achieved after removing four misfitting items and combining locally dependent items into sub-tests. NAS item functioning improved significantly following these minor modifications. In addition, by combining particular response options upon scoring, researchers can utilize our modified version without the need to alter current response formatting, thus offering them greater precision in their measurement of nonattachment. Ordinal-to-interval conversion tables presented in the manuscript further increases precision of our proposed 26-item version of the instrument and enables use of the scale without the need to violate fundamental assumptions of parametric statistics.

**Keywords** Nonattachment scale · Rasch analysis · Psychometrics · General population · New Zealand

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## Introduction

The concept of nonattachment is novel in psychology and is inspired by Buddhist psychology (Sahdra and Shaver 2013). While Western attachment theory was developed in the context of a child attaching to a significant adult figure in a secure or insecure way, attachment in Buddhism has a negative connotation (Sahdra et al. 2010). According to Sahdra et al. (2010), Buddhist literature defines attachment as "a mental affliction that distorts the cognition of its object by exaggerating its admirable qualities and screening out its disagreeable qualities" (p.116). Attachment in this sense is manifested by craving for desirable objects, situations, and relationships and also aversion to undesirable ones (McIntosh 1997).

Attachment may overlap with anxious attachment in Western psychological theory in terms of clinging, insecurity, and worry (Sahdra et al. 2010). In contrast, nonattachment is "a flexible, balanced way of relating to one's experience without clinging to or suppressing them" (Sahdra et al. 2015, p.2). It releases the mind from rigid thinking patterns and negative feelings associated with clinging and aversion (McIntosh 1997). Nonattachment is different than pathological detachment and dissociation in that the mind is actively engaged in activities while remaining flexible enough to allow events to take their course (Sahdra et al. 2010). Similar to mindfulness, letting go is the distinct characteristic of nonattachment, which is linked to adaptive functioning of the mind (Kabat-Zinn 1994; Sahdra et al. 2010).

Nonattachment, or the lack of possessive and mental fixations and clinging, is considered a key element by which mindfulness cultivates psychological wellbeing (McIntosh 1997; Brown et al. 2007; Grabovac et al. 2011; Coffey and Hartman 2008; Coffey et al. 2010; Ju and Lee 2015; Tran et al. 2014). Mindfulness is often defined as "paying attention in a particular way: on purpose, in the present moment, and

nonjudgmentally" (Kabat-Zinn 1994, p.4). The efficacy of so-called mindfulness-based interventions treating various psychological, psychiatric, and physical problems has been widely documented (Chiesa and Malinowski 2011).

Early discussions on the relationship between nonattachment and mindfulness in psychology were raised by McIntosh (1997) who compared Zen Buddhist philosophy and empirical social psychology and suggested that attachment leads to ruminations of unattained goals, which is detrimental to mental health. In contrast, mindful attention and awareness may have positive impacts on overall health via reducing attachment to self, certain objects, and outcomes. Brown et al. (2007) agreed that nonattachment was a key variable that explains how mindfulness may exert beneficial effects.

Grabovac et al. (2011) identified habitual attachment reactions to pleasant feelings and aversion to unpleasant feelings as a central factor that leads to unhappiness and proposed that mindfulness interventions produced salutary outcomes through developing nonattachment to pleasant feelings and reducing aversion to unpleasant feelings. Coffey and Hartman (2008) proposed that emotion regulation, nonattachment, and reduced rumination mediated the inverse relationship between mindfulness and psychological distress. They later tested and confirmed the positive impact of mindfulness on mental health indicators including not only psychological distress but also flourishing, through the same mechanisms (Coffey et al. 2010). Furthermore, the mediating effects of nonattachment have been investigated cross-culturally. A Korean study showed that nonattachment partially mediated the relationship between mindfulness and psychological well-being (Ju and Lee 2015). Nonattachment also partially mediated the negative associations between mindfulness and depression in German and Spanish samples of meditators (Tran et al. 2014).

Despite the growing interests in the beneficial effects of nonattachment, much of the previous research has had to rely on questionnaires about related concepts due to the absence of scales developed specifically to assess nonattachment. Coffey and Hartman (2008) and Coffey et al. (2010), for example, used the Linking Inventory (McIntosh and Martin 1992) to measure nonattachment. This scale presents dichotomous, forced-choice items measuring the extent to which respondents believe their happiness is not contingent upon the attainment of positive outcomes. An example item is "One day you realize that you have all the things you want—the job you want, the spouse you want, the free time you want," and the two response options for this question are "This will not directly influence how happy I am, because happiness is something I determine, regardless of what happens to me" and "If I have all the things I want, then I will be very happy" (McIntosh and Martin 1992). Such an instrument is limited in accurately discriminating between individual nonattachment levels.

In response to the lack of nonattachment measures, the 30-item Nonattachment Scale (NAS) (Sahdra et al. 2010) was specifically developed to assess nonattachment and is explicitly based on Buddhist nonattachment theory. Items cover a wide range of topics in life such as nonattachment to people (e.g., I am not possessive of the people I love), nonattachment to possessions (e.g., I am not possessive of the things I own), nonattachment to money (e.g., The amount of money I have is not important to my sense of who I am), nonattachment to success, perfect self, and perfect life. Items are rated on a 6-point Likert scale ranging from 1 (*disagree strongly*) to 6 (*agree strongly*), with high ratings representing high levels of nonattachment except for three negatively worded items (items 4, 13, and 24). A uni-dimensional structure was revealed by factor analyses (Sahdra et al. 2010) and confirmed by the Chinese version of the NAS (Zhao and Chen 2013).

In Sahdra et al. (2010), the psychometric properties of the NAS were evaluated in several samples. Specifically, known-groups validity was supported by higher scores of meditators than that of non-meditators. The scale showed high internal consistency, as indicated by Cronbach's alpha coefficients of above .90 in different samples. The scale was also stable over time, thus exhibiting adequate test-retest reliability. The convergent validity of the NAS was tested against a wide range of indicators, and results showed that nonattachment had negative correlations with anxious attachment and materialism and positive correlations with mindfulness, acceptance of events and experiences, nonreactivity, self-compassion, noncontingent happiness, and autonomous motivation (Sahdra et al. 2010). Discriminant validity of the scale was confirmed by negative correlations with avoidant attachment, dissociation from one's experience, alexithymic tendencies, and impersonal motivational orientation.

Association between the NAS and wellbeing was also examined. Results suggested that the NAS was positively correlated with adaptive personality traits, positive mood, satisfaction with life, and eudemonic well-being and negatively correlated with neuroticism, depression, anxiety, stress, and difficulties in emotion regulation (Sahdra et al. 2010). In addition, positive relations between nonattachment and adaptive interpersonal functioning including social relatedness, empathy, and generosity were reported. In summary, the NAS has good psychometric properties based on the results from a classical testing approach (Sahdra et al. 2010).

The reliability and validity of the NAS has also been supported by other studies. For instance, some studies including cross-cultural ones documented high Cronbach's alpha values of the NAS (Lamis and Dvorak 2013; Ju and Lee 2015; Zhao and Chen 2013). Nonattachment was found to be positively associated with satisfaction of life and self-determination (Zhao and Chen 2013) and negatively associated with suicidal

rumination and depressive symptoms (Lamis and Dvorak 2013; Ju and Lee 2015), mind wandering (Epel et al. 2012), and anxiety and perceived stress (Zhao and Chen 2013). Sahdra and Shaver (2013) also investigated nonattachment in relation to anxious and avoidant attachment, and the findings suggested that nonattachment predicted cognitive rigidity measured by closed-mindedness beyond avoidant and anxious attachment. Most recently, Sahdra et al. (2015) found that nonattachment predicted prosocial behaviors of helpfulness and kindness in adolescents.

Considering nonattachment appears to play a significant role in understanding links between mindfulness and well-being; researchers have called for additional studies on this key variable (Tran et al. 2014). Comparing the relationship between Western attachment theory and Buddhist nonattachment is also said to be valuable (Sahdra and Shaver 2013). Responding to these needs requires a conceptually sound scale with good psychometric properties. Although the emerging evidence points to satisfactory psychometric properties of the NAS, the NAS is a relatively new scale, and its item functioning has not been explored in detail.

The aim of the present study is to apply Rasch analysis to investigate the psychometric properties of the NAS using Rasch analysis and to refine the NAS if misfit to a Rasch model is identified. Nonattachment has been receiving much attention in the recent psychological literature as a key component of the mechanisms in which mindfulness may bring its benefits, but only one instrument, the NAS, assesses this construct. The present study is the first to conduct Rasch analysis on the NAS (Sahdra et al. 2010) to examine its psychometric properties in detail and to explore whether the scale could be further refined. The study aims to provide an ordinal-to-interval conversion table to facilitate future research on nonattachment by allowing researchers to use the NAS without the need to break statistical assumptions of parametric tests (Tennant and Conaghan 2007).

## Method

### Participants

Ages of 434 participants ranged from 18 to 91, with a mean age of 52.81 (SD = 17.06). To investigate DIF in demographics including age, three age groups with approximately equal size were created: 18–45 ($n$ = 143), 46–62 ($n$ = 145), and 63–91 ($n$ = 146). The majority of participants was Caucasian ($n$ = 356; 82 %), followed by Māori ($n$ = 37, 9 %), Asian ($n$ = 12, 3 %), Pasifika ($n$ = 12, 3 %), and other ($n$ = 8, 2 %). Nine participants did not report their ethnicities. Because there was only a small percentage of non-Caucasians in the sample, Māori, Asian, and Pasifika were combined with "other" for DIF analyses on ethnicity. With regard to religion, 49 % described themselves as religious, 47 % as nonreligious, and 18 % did not provide an answer about their religious affiliation.

Participants who never practiced meditation accounted for 39 % of the sample, followed by 29 % who regularly practiced meditation, and 25 % who had tried or used to practice meditation regularly; 8 % had missing information on meditation experience. To investigate the difference in nonattachment between meditators and non-meditators, people who practice meditation regularly were treated as meditators ($n$ = 125), and the rest three categories were combined into the group of non-meditators ($n$ = 275).

### Procedure

This study was approved by the authors' institutional ethics committee. Questionnaires with a self-addressed prepaid return envelope were posted to 4000 individuals randomly selected from the New Zealand national electoral roll. In total, 434 participants (154 male, 279 female, 1 missing value) returned the questionnaire, which represents a response rate of 11 %.

### Measures

The NAS is a 30-item self-report questionnaire that has been described as measuring nonattachment rooted in Buddhism (Sahdra et al. 2010). The NAS yields a single score of nonattachment by computing the mean of all items. Sample items include "I can accept the flow of events in my life without hanging onto them or pushing them away" and "I can remain open to what life offers me regardless of whether it seems desirable or undesirable at a particular time." All items use a 6-point Likert scale response format ranging from 1 (*disagree strongly)* to 6 (*agree strongly*), with higher scores indicating higher level of nonattachment, except for items 4, 13, and 24, which needed to be reverse coded first. The Cronbach's alpha in the present sample was 0.94.

### Data Analysis

The IBM SPSS v.22 was used for descriptive and reliability analyses and the RUMM2030 software for Rasch analysis (Andrich et al. 2009) of the NAS. Data from an SPSS file were formatted and saved as an ASCII file to be imported into the RUMM2030 software. The initial analysis output was subjected to the likelihood ratio test to confirm appropriateness of the unrestricted (partial credit) version of the model. The Rasch analysis followed the sequence advanced by Siegert et al. (2010).

The Rasch analysis progresses in an iterative way starting with the overall assessment of the model fit followed by examining the threshold map to identify any items displaying

disordered thresholds. When greater ability of a person on a construct (e.g., nonattachment) is not constantly associated with a gradual increase of ordinal-scale scores for that particular item, then a threshold is considered disordered. Disordered thresholds can be ordered by collapsing closest response options.

When satisfactory adjustment of all disordered thresholds is completed, the worst fitting items are deleted one at a time followed by testing the overall model fit. Also, the residual correlation matrix is examined using conservative criteria of 0.20 above the mean of all residual correlations (Andrich 2011). Items correlating above this level are considered as locally depended and are combined into sub-tests followed by a test of the overall fit of the model.

This iterative process continues until both individual item and overall model fit are satisfactory, and there is clear evidence of uni-dimensionality. A requirement is that there is no significant item-trait interaction reflected by an overall and individual item chi-square fit statistic ($p > 0.05$, Bonferroni adjusted). Fit statistics also includes overall item and person fit-residuals, which should have a standard deviation close to 1.00 and a mean close to 0.00 in case of an excellent fit. At the individual item level, fit residuals should be between −2.50 and +2.50. DIF testing should show no significant differences in item functioning (Bonferroni adjusted) between age, gender, and other personal factors.

Dimensionality is tested by an independent-samples *t* test comparing person locations for two groups of items with the highest positive and the highest negative loadings on the first principal component after removing the Rasch factor. Uni-dimensionality is confirmed if the number of significant *t* test comparisons is below 5 % or binominal confidence intervals for proportions overlap for 5 % of the lower bound for non-significant *t* tests.

## Results

The initial test of the model fit (Table 1, test 1) showed good reliability of the NAS scale as indicated by a person separation index (PSI) score of 0.93. However, the overall fit to the model was poor ($\chi^2(180) = 642.73$, $p < 0.001$), and 13 out of 30 items had disordered thresholds. Therefore, threshold ordering was addressed by rescoring of the NAS items prior to any further analyses.

For the initial analysis, an independent-samples *t* test was conducted to compare the set of person estimates from the three items with the highest positive loadings on the first principal component with the set of estimates from the three items with the highest negative loadings. *T* tests between both sets calibrated to the same metric showed that 15 % of the *t* test comparisons were significant. The exact amount of acceptable deviations based on sample size was estimated using a binominal test. The overlap of 12 % found on the lower bound surrounding *t* test failed to confirm uni-dimensionality of the initial solution (Table 1, test 1).

### Item Rescoring

Rescoring of the NAS items was conducted in an iterative fashion. Disordered thresholds were dealt with by collapsing response categories 2 (*disagree moderately*) and 3 (*disagree slightly*) together and then collapsing response categories 4 (*agree slightly*) and 5 (*agree moderately*) together. Figure 1 shows the category response probability curves for item 1 before (disordered thresholds) and after rescoring (ordered thresholds).

Even though only 13 items presented with disordered thresholds, all items in the scale were rescored in the same manner. This has the advantage that the complexity of rescoring algorithms is minimized for future users of the scale, while accepting some minor loss of discriminability among items that originally did not present with disordered thresholds. The uniform rescoring improved the overall fit to the model, but acceptable criteria were not achieved ($\chi^2(180) = 469.44$, $p < 0.001$, Table 1, test 2). In the following stage, items with poorest fits (fit residuals above 2.50) were removed one at a time, with subsequent tests of the overall fit to the model.

**Table 1** Summary of fit statistics for the sequence of Rasch analyses of the NAS including: (1) original NAS, (2) after uniform item rescoring, (3) after deleting items 4, 13, 24, and 25, (4) after creating sub-tests, and (5) after splitting item 29 for DIF by age

| | Item fit residual | | Person fit residual | | Goodness of fit | | PSI | Independent samples *t* test | |
|---|---|---|---|---|---|---|---|---|---|
| Tests | Value | SD | Value | SD | $\chi^2$ (df) | *p* | | % ST | % LB |
| 1 | 0.92 | 3.38 | −0.23 | 2.02 | 642.73 (180) | <0.001 | 0.93 | 15.14 | 11.95 |
| 2 | −0.07 | 2.53 | −0.53 | 2.17 | 469.44 (180) | <0.001 | 0.92 | 16.13 | 12.86 |
| 3 | −0.36 | 1.53 | −0.64 | 2.03 | 250.53 (156) | <0.001 | 0.92 | 15.14 | 11.95 |
| 4 | 0.10 | 1.49 | −0.49 | 1.46 | 68.23 (60) | 0.22 | 0.90 | 5.71 | 3.23 |
| Final | 0.11 | 1.39 | −0.48 | 1.45 | 68.08 (66) | 0.41 | 0.90 | 5.71 | 3.23 |

ST significant *t* tests, *LB* lower bound of the confidence interval (95 %)

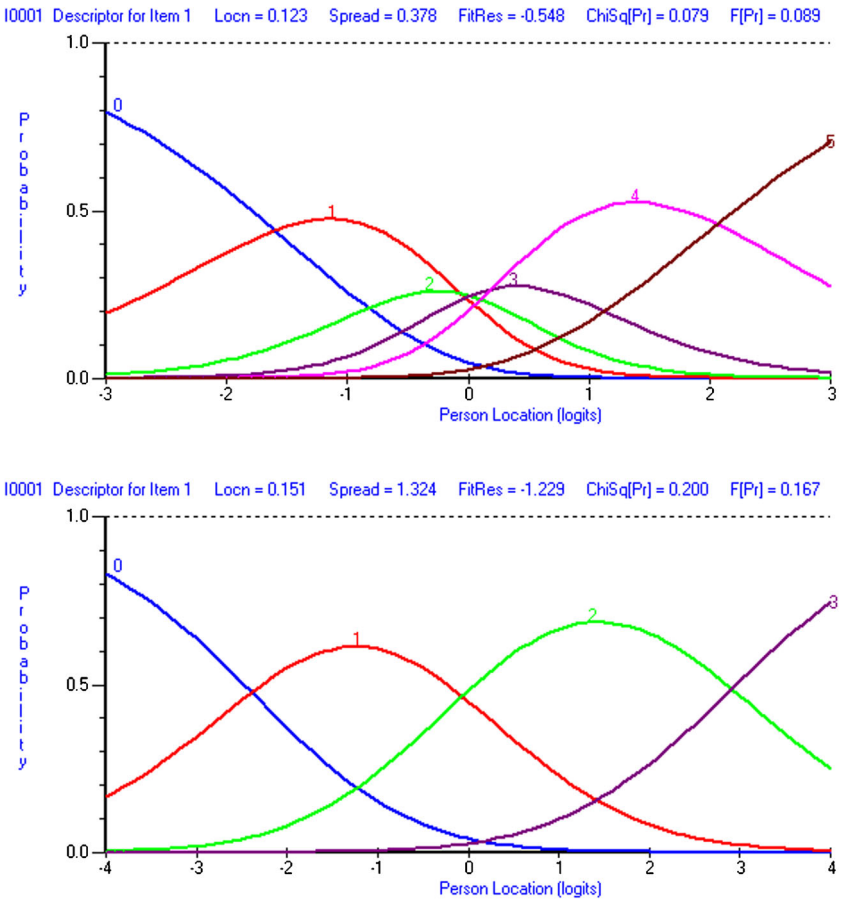


**Fig. 1** Item category probability curves illustrating disordered thresholds for NAS item 1 before rescoring (*top panel*) and orderly thresholds after rescoring (*bottom panel*)

## Deleting Non-Fitting Items

After uniform rescoring, fit residuals of all 30 NAS items were examined. Table 2 shows relative difficulty or location of each item on the Rasch scale in logit units of probability. Higher positive values indicate higher degree of item difficulty with just few individuals obtaining higher scores (e.g., item 2 "I can let go of regrets and feelings of dissatisfaction about the past"). Conversely, negative values indicate relative easiness of items with more people scoring higher on those items (e.g., item 6 "I can enjoy pleasant experiences without needing them to last forever"). Four non-fitting items (4, 13, 24, and 25) were identified. All these items had fit residuals above the acceptable value of 2.50 (range 3.89 to 8.19), and items 4 and 24 had the highest chi-square values (Table 2), indicating poor fit to the Rasch model. These non-fitting items were removed prior to continuing with the analysis.

In addition to having high fit residuals, items 4, 13, 24, and 25 also displayed lower loadings on the first principal component and item-to-total correlations (Table 2). However, even after removing these four misfitting items, the overall person-item interaction chi-square was still significant ($\chi^2(156) = 250.53$, $p < 0.001$, Table 1, test 3). The residual correlation matrix was examined next for local dependency between items because it affects fit estimations including test information and discrimination parameters.

## Local Dependency

Residual correlations exceeding 0.20 above the mean of all residual correlations are indicative of local dependency between items. When the residual correlation matrix was analyzed, eight groups of locally dependent items were identified and combined into sub-tests (sub-test 1: items 1 and 2; sub-test 2: items 3, 5, and 16; sub-test 3: items 6, 7, 14, 15, and 23; sub-test 4: items 8 and 30; sub-test 5: items 10, 11, and 28; sub-test 6: items 12, 26, and 27; sub-test 7: items 17, 18, and 22; sub-test 8: items 19, 20, and 21). This solution resulted in a good fit to the Rasch model ($\chi^2(60) = 68.23$, $p > 0.05$, Table 1, test 4), without a need to exclude any further items.

## Test for Uni-Dimensionality

For test 4, 23 (6 %) *t* test comparisons out of 403 were significant. The exact amount of acceptable deviations based on sample size was estimated using a binominal test. The overlap of 3 % found on the lower bound surrounding *t* test confirms

**Table 2** Item difficulty (location), item fit residual, chi-square, and corrected item-to-total correlation for NAS items from after rescoring (1) and chi-square values after rescoring and removing items 4, 13, 24, and 25 (2)

| *N* | Item | Location | Fit residuals | Chi-square (1) | Chi-square (2) | Item-total | Loading 1st PC |
|---|---|---|---|---|---|---|---|
| 1 | Accept flows of events | 0.15 | −1.23 | 8.56 | 11.63 | 0.64 | 0.67 |
| 2 | Let go of the past | 0.85 | −0.35 | 3.48 | 9.96 | 0.61 | 0.65 |
| 3 | Calm even if things not going my way | 0.58 | −0.90 | 3.57 | 5.16 | 0.63 | 0.66 |
| 4 | Hard time appreciating others' successes | 0.11 | 4.94 | 49.45 | – | 0.31 | 0.32 |
| 5 | Remain open to life offers | 0.04 | −0.46 | 7.36 | 9.57 | 0.62 | 0.66 |
| 6 | No need pleasant experiences lasting | −0.49 | −0.93 | 3.80 | 6.11 | 0.58 | 0.64 |
| 7 | View problems as issues to work on | −0.53 | −1.23 | 13.72 | 14.65 | 0.66 | 0.70 |
| 8 | Not upset about damaged possessions | 0.79 | 1.13 | 14.84 | 10.95 | 0.53 | 0.57 |
| 9 | Identity irrelevant to money | 0.13 | 1.35 | 11.04 | 19.01 | 0.48 | 0.51 |
| 10 | Not denying mistakes | −0.08 | 0.50 | 6.41 | 10.94 | 0.54 | 0.57 |
| 11 | Accept flaws | 0.07 | −1.52 | 8.12 | 5.33 | 0.64 | 0.68 |
| 12 | Not hanging on to family and friends | −0.30 | −1.15 | 11.36 | 10.40 | 0.61 | 0.65 |
| 13 | Upset if things aren't the way I want | 0.96 | 4.00 | 50.21 | – | 0.29 | 0.30 |
| 14 | Nonattachment to pleasure of life | 0.02 | −1.73 | 14.69 | 6.97 | 0.63 | 0.68 |
| 15 | Take joy in others' achievements | −0.39 | −2.02 | 10.31 | 3.78 | 0.64 | 0.67 |
| 16 | Happy regardless of what is going on in life | 0.75 | −0.45 | 3.96 | 1.84 | 0.61 | 0.65 |
| 17 | Face up to life difficulties | −0.26 | −1.38 | 14.23 | 5.51 | 0.62 | 0.67 |
| 18 | Open reflecting past mistakes and failings | −0.68 | −0.74 | 13.32 | 15.14 | 0.45 | 0.51 |
| 19 | Nonattachment to perfect life | −0.30 | −4.12 | 33.32 | 24.02 | 0.74 | 0.78 |
| 20 | Comfortable being ordinary | −0.18 | −1.41 | 9.19 | 4.80 | 0.63 | 0.67 |
| 21 | Remain open to negative thoughts | −0.12 | −0.97 | 3.74 | 1.70 | 0.60 | 0.65 |
| 22 | See own problems without blaming others | −1.07 | −1.12 | 7.98 | 8.98 | 0.52 | 0.56 |
| 23 | Fine with pleasant experiences end | −2.57 | −3.29 | 18.47 | 14.87 | 0.67 | 0.72 |
| 24 | Preoccupied by threats and fears | 0.46 | 8.19 | 87.76 | – | 0.27 | 0.29 |
| 25 | Not possessive of people | 0.55 | 3.89 | 14.40 | – | 0.48 | 0.52 |
| 26 | Let people go if they wish | 0.08 | 0.63 | 6.39 | 10.18 | 0.51 | 0.55 |
| 27 | No need to escape bad experiences | 0.49 | −2.10 | 8.96 | 3.26 | 0.67 | 0.70 |
| 28 | Admit shortcomings | −0.03 | −1.34 | 9.96 | 3.74 | 0.62 | 0.67 |
| 29 | Not overwhelmed after significant losses | 0.39 | −0.21 | 6.05 | 10.54 | 0.53 | 0.58 |
| 30 | Not possessive of things | 0.57 | 1.76 | 14.81 | 21.51 | 0.46 | 0.49 |

uni-dimensionality of the current solution (Table 1, Test 4). The test for uni-dimensionality for the final model was identical.

### Differential Item Functioning (DIF)

DIF analysis was conducted for the factors gender, age, ethnic group, affiliation with a religion, and meditation experience. A significant DIF effect by age ($F(2) = 7.02$, $p < 0.001$) was found for item 29 ("I experience and acknowledge grief following significant losses, but do not become overwhelmed, devastated, or incapable of meeting life's other demands"). Graphical examination showed that the means were only systematically lower across all observed confidence intervals for the youngest (18–45 years) of the three age groups. Therefore, item 29 was split for age resulting in further improvement of the model fit of the final model ($\chi^2(66) = 68.08$, $p = 0.41$, Table 1, final). No other significant DIF effects were observed.

### Person-Item Threshold Distribution

Figure 2 shows the person-item threshold distribution, where item difficulty is plotted against person ability on the same logit scale for the final model (Table 1, final). Ability refers to an individual's level of nonattachment, which is the latent trait measured by the NAS. The person threshold distribution was close to normal, with a tendency for more values at the higher end of the spectrum. Overall, the item threshold distribution shows satisfactory coverage of people's abilities on the latent trait.

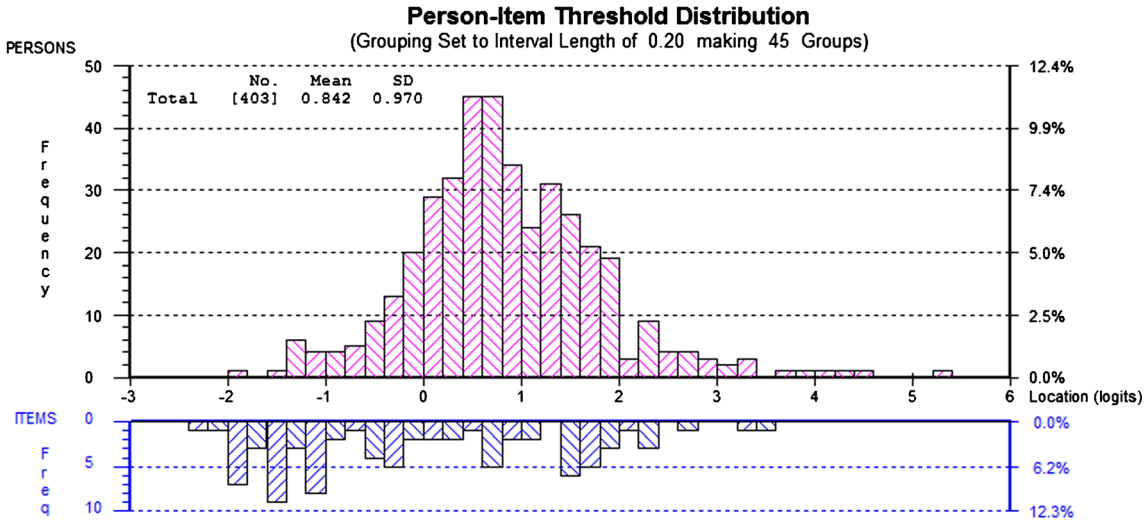


**Fig. 2** Person-item threshold distribution for 434 participants and 26 NAS items after uniform rescoring, deleting non-fitting items, creating sub-tests, and splitting item 29 by age including the three age groups

## Equating Test

The means of person estimates from the full 30-item NAS and the 26-item version were compared using a paired-samples *t* test. The difference between the person estimates of the two versions was significant ($t(402) = 4.29$, $p < 0.001$), indicating difference in the ability of the 26-item version to discriminate between individual nonattachment levels compared to the original 30-item version. Table 2 shows that the deleted items 4, 13, 24, and 25 have lower item-to-total correlations and loadings on the first principal component, indicating that these items are less consistent with the latent variable than the remaining items.

## Ordinal-to-Interval Conversion Table

Table 3 shows how ordinal raw scores of the 26-item NAS can be converted to interval scores. Since response categories 2 and 3 as well as 4 and 5 have been merged, responses to *disagree strongly* are rescored as 0, responses to *disagree moderately* and *disagree slightly* are rescored as 1, responses to *agree slightly* and *agree moderately* are rescored as 2, and responses to *agree strongly* are rescored as 3. Therefore, the sum of the rescored values for all 26 items now ranges from 0 to 78. These raw ordinal scores are converted into interval-level mean scores ranging from 1.00 to 6.00, compatible to the original NAS scoring system. Due to the above-reported DIF between people aged from 18 to 45 and people aged 46 to 91, raw and conversion scores are presented separately for these two age groups. Note that the response format of the NAS does not need to be altered in order to be able to use the conversion table, as all rescoring algorithms can also be applied retrospectively.

Scores from the revised NAS scale are highly correlated with those of the original NAS scale ($r = 0.93$, $p < 0.001$). The result of an independent-samples *t* test between meditators (mean = 3.82, SD = 0.51) and non-meditators (mean = 3.65, SD = 0.52 was significant ($t(398) = 3.00$, $p < 0.05$). This indicates that the revised NAS scale appears to have discriminative validity.

## Discussion

A robust nonattachment scale is of utmost importance for investigating the mediating effects of nonattachment in models that describe the psychological health benefits of mindfulness (McIntosh 1997; Brown et al. 2007; Grabovac et al. 2011; Coffey and Hartman 2008; Coffey et al. 2010; Ju and Lee 2015; Tran et al. 2014). The present Rasch analysis enabled a detailed examination of the psychometric properties of the NAS (Sahdra et al. 2010). Misfits to the Rasch model were identified for the original 30-item NAS, and, as a result, certain modifications were performed to improve the psychometric properties of the scale.

Psychometric properties of the NAS were robust after uniform reordering thresholds, deleting four misfit items, and sorting out local dependency. Uni-dimensionality testing demonstrated that our modified 26-item NAS measures one latent variable, namely nonattachment. NAS item functioning was improved considerably by these minor modifications without the need to alter the current response format. Together with the ordinal-to-interval conversion tables presented here, the 26-item version provides more precise measurement of nonattachment and allows use of the scale without the need to

**Table 3** Converting from a uniformly rescored 26-item Nonattachment Scale raw score (0 to 78) to an interval scale in logit units and in mean scores ranging from 1 to 6 for the younger (18–45 years) and the older (46–91 years) age groups

| Raw score* | Interval measure | | | | Raw score* | Interval measure | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Age 18–45 years | | Age 46–91 years | | | Age 18–45 years | | Age 46–91 years | |
| | Logit | Mean | Logit | Mean | | Logit | Mean | Logit | Mean |
| 0 | −4.13 | 1.00 | −4.20 | 1.00 | 40 | −0.24 | 3.07 | −0.26 | 3.13 |
| 1 | −3.42 | 1.38 | −3.48 | 1.39 | 41 | −0.17 | 3.11 | −0.18 | 3.17 |
| 2 | −2.98 | 1.61 | −3.03 | 1.63 | 42 | −0.09 | 3.15 | −0.11 | 3.21 |
| 3 | −2.71 | 1.76 | −2.75 | 1.78 | 43 | −0.02 | 3.19 | −0.03 | 3.25 |
| 4 | −2.52 | 1.86 | −2.56 | 1.89 | 44 | 0.06 | 3.23 | 0.04 | 3.29 |
| 5 | −2.38 | 1.94 | −2.41 | 1.97 | 45 | 0.13 | 3.27 | 0.12 | 3.33 |
| 6 | −2.26 | 2.00 | −2.29 | 2.03 | 46 | 0.21 | 3.31 | 0.20 | 3.38 |
| 7 | −2.16 | 2.05 | −2.19 | 2.09 | 47 | 0.29 | 3.35 | 0.27 | 3.42 |
| 8 | −2.08 | 2.09 | −2.10 | 2.14 | 48 | 0.37 | 3.40 | 0.35 | 3.46 |
| 9 | −2.00 | 2.13 | −2.02 | 2.18 | 49 | 0.45 | 3.44 | 0.43 | 3.50 |
| 10 | −1.94 | 2.17 | −1.96 | 2.21 | 50 | 0.53 | 3.48 | 0.51 | 3.55 |
| 11 | −1.87 | 2.20 | −1.89 | 2.25 | 51 | 0.61 | 3.52 | 0.59 | 3.59 |
| 12 | −1.82 | 2.23 | −1.83 | 2.28 | 52 | 0.69 | 3.57 | 0.67 | 3.63 |
| 13 | −1.76 | 2.26 | −1.78 | 2.31 | 53 | 0.77 | 3.61 | 0.75 | 3.68 |
| 14 | −1.71 | 2.29 | −1.73 | 2.34 | 54 | 0.85 | 3.65 | 0.83 | 3.72 |
| 15 | −1.66 | 2.32 | −1.68 | 2.37 | 55 | 0.93 | 3.70 | 0.91 | 3.76 |
| 16 | −1.61 | 2.34 | −1.63 | 2.39 | 56 | 1.01 | 3.74 | 0.99 | 3.81 |
| 17 | −1.56 | 2.37 | −1.58 | 2.42 | 57 | 1.10 | 3.78 | 1.07 | 3.85 |
| 18 | −1.52 | 2.39 | −1.53 | 2.44 | 58 | 1.18 | 3.83 | 1.16 | 3.89 |
| 19 | −1.47 | 2.42 | −1.49 | 2.47 | 59 | 1.26 | 3.87 | 1.24 | 3.94 |
| 20 | −1.42 | 2.44 | −1.44 | 2.49 | 60 | 1.35 | 3.92 | 1.32 | 3.98 |
| 21 | −1.38 | 2.47 | −1.39 | 2.52 | 61 | 1.43 | 3.96 | 1.41 | 4.03 |
| 22 | −1.33 | 2.49 | −1.34 | 2.54 | 62 | 1.52 | 4.01 | 1.49 | 4.08 |
| 23 | −1.28 | 2.52 | −1.30 | 2.57 | 63 | 1.61 | 4.06 | 1.58 | 4.13 |
| 24 | −1.23 | 2.55 | −1.25 | 2.60 | 64 | 1.71 | 4.11 | 1.68 | 4.18 |
| 25 | −1.18 | 2.57 | −1.20 | 2.62 | 65 | 1.81 | 4.16 | 1.77 | 4.23 |
| 26 | −1.13 | 2.60 | −1.14 | 2.65 | 66 | 1.91 | 4.22 | 1.87 | 4.28 |
| 27 | −1.07 | 2.63 | −1.09 | 2.68 | 67 | 2.02 | 4.27 | 1.98 | 4.34 |
| 28 | −1.02 | 2.66 | −1.04 | 2.71 | 68 | 2.13 | 4.34 | 2.09 | 4.40 |
| 29 | −0.96 | 2.69 | −0.98 | 2.74 | 69 | 2.26 | 4.40 | 2.21 | 4.46 |
| 30 | −0.90 | 2.72 | −0.92 | 2.77 | 70 | 2.40 | 4.48 | 2.34 | 4.54 |
| 31 | −0.84 | 2.75 | −0.86 | 2.81 | 71 | 2.55 | 4.56 | 2.49 | 4.61 |
| 32 | −0.78 | 2.79 | −0.80 | 2.84 | 72 | 2.72 | 4.65 | 2.65 | 4.70 |
| 33 | −0.71 | 2.82 | −0.73 | 2.87 | 73 | 2.92 | 4.76 | 2.84 | 4.80 |
| 34 | −0.65 | 2.85 | −0.67 | 2.91 | 74 | 3.16 | 4.88 | 3.06 | 4.92 |
| 35 | −0.58 | 2.89 | −0.60 | 2.94 | 75 | 3.46 | 5.04 | 3.34 | 5.07 |
| 36 | −0.52 | 2.92 | −0.54 | 2.98 | 76 | 3.84 | 5.25 | 3.70 | 5.27 |
| 37 | −0.45 | 2.96 | −0.47 | 3.02 | 77 | 4.42 | 5.55 | 4.24 | 5.56 |
| 38 | −0.38 | 3.00 | −0.40 | 3.06 | 78 | 5.26 | 6.00 | 5.05 | 6.00 |
| 39 | −0.31 | 3.03 | −0.33 | 3.09 | | | | | |

The following uniform rescoring of response options for all 26 items is required before converting into an interval scale: 1 to 0, 2 to 1, 3 to 1, 4 to 2, 5 to 2, and 6 to 3. The 26-item raw score is calculated as the sum of rescored values from all NAS items except for items 4, 13, 24, and 25

violate fundamental assumptions of parametric statistics (Tennant and Conaghan 2007).

In the present study, the internal reliability of the original 30-item version of the NAS was found to be high, as indicated

by both PSI and Cronbach's alpha values above 0.90. The internal construct validity of the original NAS, however, is problematic, as the data of the original 30-item version did not meet the expectations of the Rasch model. The overall fit indicators suggested that the hierarchical ranking of the items varies across levels of nonattachment, which violates the required property of invariance of the scale for participants with different levels of nonattachment.

The large number of items with disordered thresholds indicated that the response format may not be ideal for the NAS. Collapsing adjacent response categories improved the overall model fit. Hence, the difference between "slightly" and "moderately" in relation to nonattachment levels assessed by those 13 items may be too small for participants to distinguish. In addition, the uni-dimensionality of the original NAS was not confirmed, possibly due to local dependency between groups of the original 30-item NAS.

At the item level, four items (items 4, 13, 24, and 25) showed misfits to the Rasch model. Among them, three items, namely item 4 ("I have a hard time appreciating others' successes when they outperform me"), item 13 ("If things aren't turning out the way I want, I get upset"), and item 24 ("I am often preoccupied by threats or fears") are negatively worded items. After removing them, the NAS contains no negatively worded items. During the original development of the NAS, positively and negatively worded items are approximately equally represented in the initial pool of 135 items (Sahdra et al. 2010). After having been reviewed by Buddhist experts during the preliminary item selection, 72 items consisting of 32 negatively worded and 40 positively worded items were retained.

Most negatively worded items, however, were discarded after factor analyses, and only three negatively worded items were retained in the final version of the 30-item NAS (Sahdra et al. 2010). The factor loading of item 24 in the original validation study was only marginally above the cut-off value of 0.40. Sahdra et al. (2010) suggested that the elimination of most negatively worded items proposed during item selection stage could reflect the different ability between Buddhist experts and respondents in interpreting these items. If that was the case, then differences between meditators and non-meditators reported in their paper could be contaminated by the different functioning of the negatively worded items in those two groups, as the sample of meditators was likely to include more Buddhists.

The three remaining negatively worded items in the original 30-item NAS did not fit the Rasch model in the present study. The weak performance of negatively worded items further indicated that those items could be hard cognitively for people to process, or the items do not necessarily represent the opposite of nonattachment. For example, item 13 implies that being upset if things are not turning out the way people want represents the opposite construct of nonattachment. However, people could be angry or disappointed instead of being upset, and thus not being upset might not be the sole indicator of nonattachment.

The misfitting item 25 ("I am not possessive of the people I love") is similar to item 26 ("I do not have to hang on to the people I love at all costs; I can let them go if they wish to go"). Compared to item 26, which contains more description, item 25 is more ambiguous, and participants may have various interpretations of what being "possessive" of people may mean. Also, item 25 is a general and sensible statement about one's self that can be easily endorsed by people, whereas item 26 emphasizes letting go, which could be more objectively evaluated against one's actual behaviors and feelings. In other words, item 25 may be subjected to a social desirability bias as it measures accepting a sensible statement about nonattachment to some extent, while item 26 tends to measure actual nonattaching behaviors and feelings and consequently may be a better reflection of the respondent's level of nonattachment.

After an acceptable model fit was achieved, the only problematic item was item 29 ("I experience and acknowledge grief following significant losses, but do not become overwhelmed, devastated, or incapable of meeting life's other demands"), which demonstrated DIF for age. Individuals with equal levels of nonattachment thus had different probabilities of responding to this item due to differences in age. Specifically, this item seemed to perform differently for people under the age of 45, possibly due to the lower probability of experiencing a significant loss than for older people. Employing this item to compare nonattachment level between old and young people is therefore problematic. However, splitting item 29 in the Rasch model and producing separate conversion tables by age groups successfully dealt with this issue.

According to the person-item map for the 26-item NAS, targeting of the new four-category response scale was good. Also, the effective targeting of item difficulty to respondent level of attachment indicated that the 26-item version of the NAS is suitable to measure nonattachment in the New Zealand general population. The easiest item to endorse is item 23 ("When pleasant experiences end, I am fine moving on to what comes next"). The most difficult item to endorse is item 2 ("I can let go of regrets and feelings of dissatisfaction about the past"). It implies that respondents seem to have a sensible attitude toward pleasure, but find it hard to let go of the past.

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**Compliance with Ethical Standards**

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Ethical Standards** The manuscript does not contain clinical studies or patient data.

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