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ORIGINAL PAPER

Validation of the Five Facet Mindfulness Questionnaire-Bangla Using Classical Test Theory and Item Response Theory

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Abstract

Objectives Mindfulness-based interventions are common in contemporary mental health practices. Hence, the assessment of mindfulness is necessary during those interventions, and the 39-item Five Facet Mindfulness Questionnaire (FFMQ) is one of the most frequently used tools. As there is a scarcity of mindfulness scales for Bangla-speaking people, we translated this questionnaire into Bangla and validated it with a Bangladeshi community sample.

Method We collected data from 532 Bangladeshi adults (mean age = 30.22; *SD* = 5.19), of which 390 were females and 142 were males. The participants completed FFMQ-Bangla, Mindfulness Attention Awareness Scale, Emotional Intelligence Scale, Depression Scale, and Openness and Neuroticism sub-scales of the Big Five Personality Inventory. Item response theory–based analysis evaluated the item quality of the Bangla FFMQ. Confirmatory factor analysis (CFA) and exploratory structural equation modeling (ESEM) assessed the scale's structural validity.

Results Item response theory–based analysis discarded 10 items. Both CFA and ESEM supported the five-faceted model (CFA: *CFI* = 0.94; *TLI* = 0.94; ESEM: *CFI* = 0.99; *TLI* = 0.99) and indicated satisfactory reliability for the remaining 29-item scale (≥ 0.80). ESEM revealed two general components (self-regulated attention and orientation to experience) encompassing the five facets (*CFI* = 0.99; *TLI* = 0.93). All those facets exhibited positive correlations with the Mindfulness Attention Awareness Scale, Emotional Intelligence Scale, and the Openness trait and negative correlations with Depression and the Neuroticism trait, revealing the scale's concurrent validity.

Conclusions Since the FFMQ-Bangla has exhibited satisfactory reliability and structural and concurrent validity, we recommend that researchers and mental health practitioners use this scale to assess mindfulness among Bangla-speaking people.

Preregistration This study is not preregistered.

Keywords Mindfulness · Item response theory · Exploratory structural equation modeling · Validity · Reliability

Mindfulness is a state of complete attention toward the present moment with a non-judgmental attitude, experiential openness, and acceptance toward one's own experience (Bishop et al., 2004). Different mental health interventions and therapies have incorporated mindfulness into their regimes, such as the mindfulness-based stress reduction technique (Kabat-Zinn, 1982, 2003; Kabat-Zinn et al., 1985, 1986), mindfulness-based cognitive therapy (Segal et al., 2018), and dialectical behavior therapy (Linehan, 1993, 2018). All those interventions have been successful in improving mental health (Hofmann et al., 2010; Kabat-Zinn, 2003). These interventions consider mindfulness as a set of skills that can be incorporated into one's behavior and mastered through practice over time.

While delivering mindfulness interventions, assessing the clients' mindfulness disposition at different stages is necessary. For this, the therapists use self-report instruments that emerged over the years. The Freiburg Mindfulness Inventory (FMI; Buchheld et al., 2001) was the first mindfulness

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questionnaire, which was followed by the development of the Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003), Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004), Cognitive and Affective Mindfulness Scale (CAMS; Feldman et al., 2007), and Southampton Mindfulness Questionnaire (SMQ; Chadwick et al., 2008). These independently developed questionnaires vary in the conceptualization of mindfulness and its latent structure. MAAS, FMI, CAMS, and SMQ hold a single-factor structure, whereas KIMS has a multidimensional structure. Over the years, the construct of mindfulness has been argued for a single-factor structure or multidimensional nature (Brown & Ryan, 2003; Dimidjian & Linehan, 2003; Segal et al., 2018). For example, Brown and Ryan (2003) defined mindfulness as attention to and awareness of the present moment and considered the latent structure as a single-factor structure. In contrast, in dialectical behavioral therapy (Dimidjian & Linehan, 2003), mindfulness is considered multidimensional where six interrelated skills (observing, describing, participating, nonjudgmentally, one-mindfully, and effectively) were used to conceptualize mindfulness. Mindfulness-based cognitive therapy (Segal et al., 2018) defines mindfulness by several elements, including observation of present-moment experience, acceptance, nonjudge, and nonreactivity.

In an attempt to answer the question of dimensionality, Baer et al. (2006) conducted an exploratory factor analysis on data accumulated from 613 participants on all the aforementioned questionnaires. This led to the development of the Five Facet Mindfulness Questionnaire (FFMQ), where the essence of mindfulness was captured in five distinct facets. The first facet *Observe* captures people's ability to notice their own emotions, thoughts, and other environmental sensations. The *Describe* facet captures the ability to describe one's thoughts and emotions in words. *Acting with awareness (Actaware)* investigates people's ability to attend to the present moment awareness. The fourth facet, *Not judging the inner experiences (Nonjudge)*, captures the ability not to judge one's internal thoughts and emotions. The last facet, *Not reacting to the inner experience (Nonreact)*, deals with people's ability to attend to their thoughts and emotions without rumination or fixation (Baer et al., 2006).

Baer et al. (2006) reported two different models as the latent structure of FFMQ: (i) a five-facet model and (ii) a one-factor higher-order model, in which one general factor (mindfulness) encompasses all facets. However, this higher-order model of FFMQ remains open to debate. Baer et al. (2006) found that only among the participants who practice meditation (meditating sample) did all five facets load on the general factor. However, among those who did not practice meditation (non-meditating sample), the *Observe* facet did not load on the general factor. Though *Observe* is typically considered a key concept in mindfulness, there could be a discrepancy in comprehension of *Observe* among people with or without meditation experience (Baer et al., 2004). Nonmeditators may characterize *Observe* as a neutral or maladaptive form of attention instead of attention characterized by acceptance, nonjudgment, and curiosity guided by mindfulness meditation practice (Baer et al., 2022). Interestingly, Tran et al. (2013) provided evidence of a two-factor higher-order latent structure: (a) self-regulated attention and (b) orientation to experience, encompassing all five facets of FFMQ in community and student samples.

Though FFMQ has been validated across the clinical, community, meditating, and student samples, cultural differences are relevant and need to be acknowledged while understanding the differences in conceptualizing mindfulness across the East and the West (Haas & Akamatsu, 2019). Several countries, including India (Mandal et al., 2016; Raman et al., 2021), Sri Lanka (Baminiwatta et al., 2022), Germany (Tran et al., 2013), Italy (Giovannini et al., 2014), Japan (Sugiura et al., 2012), China (Deng et al., 2011), Brazil (Barros et al., 2015), and Australia (Taylor & Millear, 2016), have validated the FFMQ. Table 1 shows that the FFMQ's latent structure and item numbers differ in Eastern countries. Raman et al. (2021), while validating the English FFMQ in India, reported a five-facet structure with one higher-order factor. In contrast, a four-facet (excluding *Observe*) structure was reported for FFMQ-Hindi (Mandal et al., 2016). Haas and Akamatsu (2019) reported that both four-facet (excluding *Observe*) and five-facet structures exhibited good fit among college students of Bhutan using the English FFMQ. These findings highlight the importance of validating the FFMQ in Eastern countries.

To date, there has been no attempt made to validate the FFMQ in Bangla, which has impeded the progress of mindfulness-based interventions in the country. Currently, only the MAAS has been translated and validated on Bangla-speaking people (Islam & Siddique, 2016). MAAS treats mindfulness as a unidimensional construct and does not fully capture mindfulness as it focuses only on the self-awareness component (Zhuang et al., 2017). Validating FFMQ in Bangla will help us to understand a person's current state of mindfulness in a much comprehensive manner, which would facilitate the therapeutic process in clinical and counseling settings.

Mindfulness is a personal experience that might be shaped by the culture (Karl et al., 2022). Ketay et al. (2009) suggested that culture influences how our brain processes abstract stimuli and distributes attentional resources toward environmental stimuli. Mindfulness has been attributed as a vital component of cultural intelligence, providing a bridge between behavioral capability and knowledge (Thomas, 2006). The practice of mindfulness originated in the East as a part of the Buddhist tradition, then exported to the West and later returned to the East as modified therapeutic interventions (Karl et al., 2022).

Table 1 Facet and item number in the different adaptations of FFMQ

Language	Sample	Number of facets	Number of items
FFMQ-English version in India (Raman et al., 2021)	Non meditating sample ($n=300$)	Five	36
FFMQ-English version in Bhutan (Haas & Akamatsu, 2019)	College student ($n=151$)	Both four facet (excluding observe) and five facet	39
FFMQ-Hindi (Mandal et al., 2016)	Non meditating sample ($n=300$)	Four (excluding observe)	28
FFMQ-Sinhalese (Baminiwatta et al., 2022)	Nurses ($n=415$)	Six	20
FFMQ-German (Tran et al., 2013)	Community sample ($n=640$) Student sample ($n=333$)	Five	39
FFMQ-Italian (Giovannini et al., 2014)	Student sample ($n=318$) Non-student sample ($n=241$)	Five	39
FFMQ-Japanese (Sugiura et al., 2012)	College students ($n=1349$)	Five	39
FFMQ-Chinese (Deng et al., 2011)	Student sample ($n=246$)	Five	39
FFMQ-Brazilian (Barros et al., 2015)	Smokers, community participants and college students ($n=395$)	Seven	39
FFMQ-Australian (Taylor & Millear, 2016)	Paid employees ($n=380$)	Five	39

It is crucial to explore the compatibility of mindfulness as a potential global psychological trait in the context of cultural globalization. To establish mindfulness as a psychological trait across varied cultures, Karl et al. (2022) analyzed the responses to FFMQ from 16 cultural groups ($n=8541$) and found a universal conceptual structure for mindfulness. However, they also reported a substantive cultural variability among individuals in understanding the terms used in the FFMQ items. Validating FFMQ in Bangla will broaden the horizon of our understanding of the aspects of cross-cultural generalizability of FFMQ and address the individual differences caused by cultural discrepancies.

Concerning the testing of psychometric features, most of the earlier validation works performed the classical test theory (CTT)–based analyses. CTT assumes the measurement precision would be equal for all individuals and does not acknowledge the influence of individual latent-attribute level on the measurement precision (Jabrayilov et al., 2016). In contrast, item response theory (IRT) acknowledges the individual latent-attribute level. IRT relates the probability of success of each item with the estimated latent trait using a logistic function called the *option characteristic curve* (OCC; Calderon et al., 2021). For a 5-point response scale, an ideal OCC would have one non-increasing, one non-decreasing, and three unimodal response curves. Item difficulty corresponds to the latent trait level at which the probability of endorsing a particular response option is 50%. Item discrimination indicates how well a particular item can differentiate between participants across the given latent trait continuum (θ). Item information curve (IIC) and test information curve (TIC) indicates the amount of information a particular item and the test carries. These IRT parameters can be used to increase the precision of an instrument.

Thus, we set four objectives for this study. *First*, to translate the FFMQ into Bangla. *Second*, to increase the precision of the FFMQ-Bangla (FFMQ-B) using IRT-based item analysis. *Third*, to estimate reliability and provide structural validity evidence of the scale in a large community sample. *Fourth*, to collect concurrent validity evidence for the scale. To attain our *first* objective, we followed the International Test Commission guidelines (ITC; Bartram et al., 2018) to translate FFMQ. For the *second* objective, we sought to item response theory. For the *third* objective, we estimated the internal consistency reliability of FFMQ-B. To assess structural validity, we tested the four proposed models on our sample (Baer et al., 2006; Baminiwatta et al., 2022; Haas & Akamatsu, 2019; Raman et al., 2021; Tran et al., 2013): (i) Model 1: correlational five-facet model, (ii) Model 2: correlational four-facet model excluding *Observe*, (iii) Model 3: one-factor higher-order model, and (iii) Model 4: two-factor higher-order model. Typically, latent structure validation is mostly done using confirmatory factor analysis (CFA). However, CFA forces the items to load only on the corresponding factor and only provides explicit cross-loadings (correlated items of different factors) through covariance of error variance between item pairs. This pattern of relationship is not realistic (Hancock & Mueller, 2013). Thus, along with the CFA techniques, we used a state-of-the-art technique: exploratory structural equation modeling (ESEM; Asparouhov & Muthén, 2009; Marsh et al., 2009) to strengthen our validity analysis. ESEM creates a synergy between exploratory and confirmatory factor analysis by allowing the items to cross-load to represent the data more realistically and offering other methodological advances of CFA, such as estimating the fit-indices to assess model fit (Tóth-Király et al., 2017). To attain our *fourth* objective,

we calculated the correlations of FFMQ-B with emotional intelligence, MAAS, depression, neuroticism, and openness to experience. Based on existing literature (Baer et al., 2006; Deng et al., 2014) and the item contents of FFMQ-B, we developed rational predictions. We predicted (Prediction 1) that all facets would exhibit positive correlations with the constructs that include elements of mindfulness (emotional intelligence, MAAS, openness to experience) and negative correlation (Prediction 2) with constructs lacking in mindfulness elements (depression and neuroticism). We also predicted (Prediction 3) that openness to experience would most strongly correlate with the *Observe* facet since openness to experience reflects attentiveness to stimuli (Prediction 3; Baer et al., 2006). Emotional intelligence (EI) was predicted (Prediction 4) to correlate highest with the *Describe* facet since EI incorporates the ability to recognize emotional states (Prediction 4; Baer et al., 2006). MAAS was predicted (Prediction 5) to exhibit the strongest correlation with the *Actaware* facet since most of the items in the *Actaware* facet originated from MAAS (Prediction 5; Baer et al., 2006). Previous studies also reported weak to moderate positive correlations of *Nonjudge* and *Nonreact* facets with MAAS (Ramos et al., 2018). Thus, we predicted that *Nonjudge* and *Nonreact* would exhibit the same pattern in our study (Prediction 6).

Method

Participants

We conducted a large-scale online survey to gather data for this study. Any Bangladeshi citizen aged over 18 years and able to read and write Bangla was eligible to participate. Five hundred and thirty-two adults, 390 females (mean age = 29.65 years; *SD* = 5.00) and 142 males (mean age = 31.8 years; *SD* = 5.38), completed the survey. The average years of education for females and males were 15.26 ± 2.13 and 16.8 ± 0.45, respectively; 403 (76%) participants were married. The mean score of participants' social stance (individual's perceived social position in a social hierarchy measured by a single-item 10-point Likert scale: 1 for the lowest and 10 for the highest social position) was for females, 6.67 ± 2.08 and for males, 6.55 ± 2.12.

The concurrent validity evidence was drawn from a subset of our sample ($n = 254$) — 185 females (mean age = 28.82 years; *SD* = 4.66) and 69 males (mean age = 33.55 years; *SD* = 5.63). The average years of education for females and males for this subset of sample were 15.25 (*SD* = 2.11) and 16.78 (*SD* = 0.42), respectively; 193 (76%) participants were married.

Procedure

We conducted a quantitative, cross-sectional, and fully anonymous online survey with participants recruited through a convenience sampling technique. We used social media platforms like Facebook, Twitter, LinkedIn, and emails to approach the prospective participants. We sent an explanatory statement that contained information on inclusion and exclusion criteria and data confidentiality statements. The statement also indicated that their participation was voluntary and that they could withdraw from participation at any time without being impacted negatively. If the participants were happy with the statement and expressed interest in participating, we forwarded a survey link to them. At the beginning of the survey, we recorded their consent digitally. The survey took around 20 to 30 min, for which they received no monetary compensation.

Measures

FFMQ

FFMQ (Baer et al., 2006) is a 39-item questionnaire that measures an individual's mindfulness across five dimensions: *Observe* (8 items), *Describe* (8 items), *Nonjudge* (8 items), *Actaware* (8 items), and *Nonreact* (7 items). An example of an item is "When I'm walking, I deliberately notice the sensations of my body moving." Items were scored on a 5-point Likert-type scale ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*). Each facet score was computed by adding the scores on individual items. A higher total score would indicate a higher disposition of mindfulness. Baer et al., (2006) reported adequate internal consistency for the five facets of FFMQ estimated in a student sample ($n = 613$; *Observe* = 0.83, *Describe* = 0.91, *Nonjudge* = 0.87, *Actaware* = 0.87, *Nonreact* = 0.75).

FFMQ-B

We followed the ITC guidelines (Bartram et al., 2018) to translate and adapt the FFMQ. Two bilingual scholars, native to Bangladesh, did the forward translation of the FFMQ to Bangla. Two translated versions were then judged and synthesized by the authors. Subsequently, two bilingual scholars back-translated the Bangla scale into English. The authors synthesized the two back-translations, compared them with the original scale, and made necessary amendments.

Bangla MAAS

MAAS is a 15-item instrument with 6-point Likert-type response options (1 for *almost always* to 6 for *almost never*) measuring the disposition of paying attention to the present-moment experience (Brown & Ryan, 2003). An example of

an item is "I could be experiencing some emotion and not be conscious of it until sometime later." It provides a single total score where a high score would indicate a higher mindfulness disposition. We used the Bangla MAAS (Islam & Siddique, 2016), which exhibited satisfactory reliability in the Bangladeshi sample (Cronbach's alpha = 0.85; $n = 519$; Islam & Siddique, 2016).

Emotional Intelligence Scale

The Emotional Intelligence Scale (Hyde et al., 2002) is a 34-item scale with 5-point Likert-type response options (1 for *strongly disagree* to 5 for *strongly agree*). An example of an EI item is "I can encourage others to work even when things are not favorable." We translated all 34 items from English to Bangla using the forward and backward translation methods. A total score is computed by adding up all item scores. A higher total score indicates a higher level of emotional intelligence.

Depression Scale

Depression Scale (Uddin & Rahman, 2005) is a 30-item Bangla questionnaire with 5-point Likert-type response options (1 for *not at all true* to 5 for *always true*) that measures depression. A total score can be computed by summing up all item scores. A higher total score indicates a higher level of depression.

Big Five Inventory (BFI)

We measured neuroticism and openness to experience by two Bangla-translated subscales of BFI (John et al., 1991). The neuroticism subscale (8 items) measures the extent to which an individual is affectively unstable, anxious, and worried (Horner, 1996). The openness subscale (10 items) measures an individual's susceptibility to aesthetics, ideas, values, and flexibility (Costa & McCrae, 1992). An example of an item measuring openness is, "I see myself as someone who is original and comes up with new ideas." "I see myself as someone who is depressed, blue" is an example of a neuroticism item. Each item was scored on a 5-point Likert-type scale (1 for *strongly disagree* to 5 for *strongly agree*).

Data Analyses

To estimate the optimal sample size for the CFA and ESEM, we used the rule of thumb of 10 participants per item for analysis based on the structural equation modeling framework (Nicolaou & Masoner, 2013; Nunnally, 1967). Since FFMQ-B has 39 items, at least 390 participants are required. Furthermore, Monte Carlo simulation studies suggested a sample size of 200–500 to evaluate the obtained result safely when analyzing ordinal data with the WLSMV estimator. Our sample size well exceeded this requirement. The sampling adequacy for IRT analysis was assessed using a Monte Carlo simulation using the "SimDesign" package (Chalmers & Adkins, 2020) with sample size varying from 50 to 500 and calculated the average root mean squared error (RMSE) to estimate the optimal sample size for the graded response model. The RMSE became stable for $n = 450$ to 500. Our sample size again exceeded this suggested range. We used R statistical language and several statistical packages for our analysis, including lavaan for confirmatory factor analysis (Rosseel, 2012), mirt for IRT-based analysis (Chalmers, 2012), and esemComp for exploratory structural equation modeling (Silvestrin & de Beer, 2022). Figure 1 summarizes the steps we followed in the psychometric analysis.

Content Validity and Descriptive Statistics

Twelve mental health professionals independently assessed the content of 39-item FFMQ-B using a 4-point Likert-type scale (1 for *not at all relevant* to 4 for *highly relevant*). We estimated both the item-level content validity (I-CVI) and the scale-level content validity (S-CVI) using the average method. Any item with an I-CVI score > 0.83 and S-CVI > 0.90 indicates an adequate content validity (Lynn, 1986; Polit et al., 2007). We explored the descriptive statistics of our sample and checked normality assumptions.

Item Response Theory–Based Item Analysis

In the present study, we employed IRT-based analysis to examine sources of misfits among our sample before we examined the latent structure through CFA. This allowed us to identify items that carried low information regarding the mindfulness facets, exhibiting poor item-level fit and discriminatory power at an early stage of our analysis. Raman et al. (2021), in their study, employed a similar technique where first they used the Rasch analytic technique to identify misfit items and then validated their findings by employing a subsequent CFA on the same sample.

We estimated five different graded response models (Samejima, 1970) for each of the five facets of FFMQ-B using the marginal maximum likelihood estimation method with the MHRM algorithm ($n = 532$). First, we confirmed the unidimensionality of each of the five facets by categorical CFA using a weighted least square with mean and variance (WSMV) estimator and polychoric correlation. To assess the model fit, we followed the guidelines of Hu and Bentler (1999): comparative fit index (*CFI*) and the Tucker-Lewis index (*TLI*): acceptable fit ≥ 0.90, good fit ≥ 0.95; the root mean square error of approximation (*RMSEA*): acceptable fit < 0.08, good fit < 0.06; and the standardized root mean square (*SRMR*): acceptable fit < 0.10, good fit < 0.08.

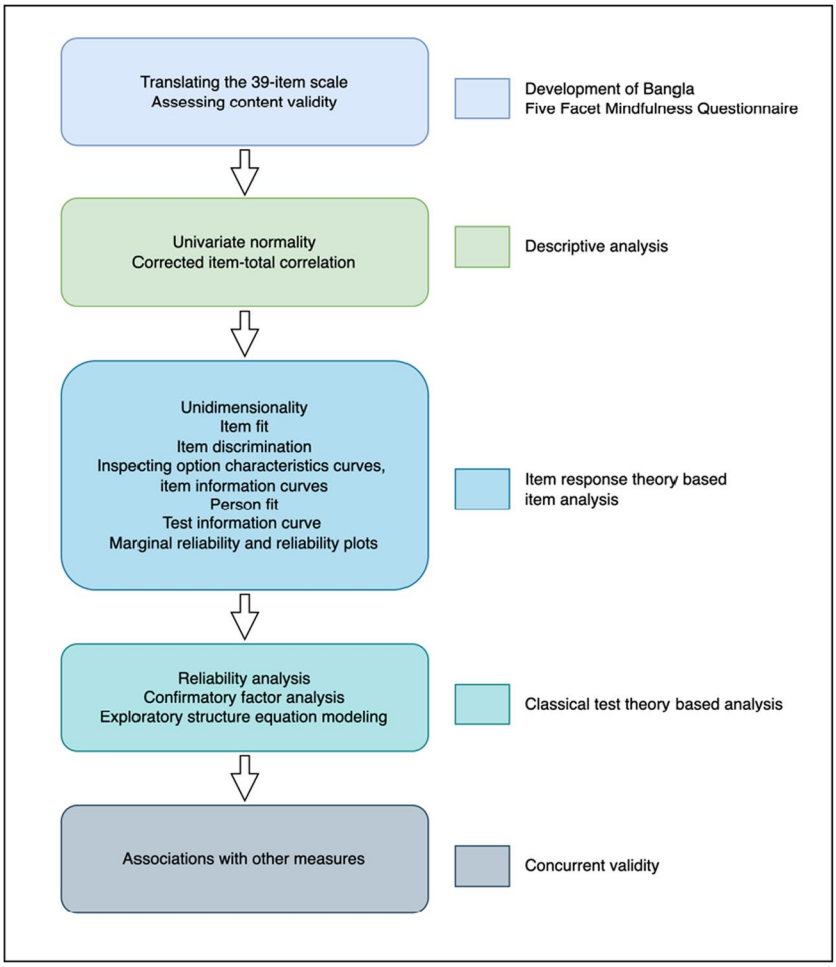

Fig. 1 Psychometric analysis flow chart

Second, we assessed the item-level fit using the *RMSEA* value associated with S-χ^2 statistics ($RMSEA < 0.08$) to identify items with poor fit and discarded them from the models. Third, we followed the guidelines of Baker (2017, pp. 26,129) to assess item discrimination and categorize them. The item discrimination range used was $0.5 \leq item\ discrimination \leq 2.0$. Item discrimination categorization was *none* = 0, *very low* = 0.01–0.34, l*ow* = 0.35–0.64, *moderate* = 0.65–1.34, *high* = 1.35–1.69, and *very high* > 1.70. We also assessed the item difficulty quality by inspecting the OCC for any visible abnormality. We also identified items that carried less information (< 0.20) by inspecting the item information curve. Fourth, person fit was assessed using the standardized fit index Z_h statistics (Desjardins & Bulut, 2018, pp. 169–192). $Z_h < -2$ should be considered a misfit. Fifth, the overall test information curve was inspected to identify the range of latent continuum (θ) with the highest information and least standard error of measurement. Next, we estimated marginal reliability coefficients for the fitted IRT model. Finally, we inspected the person-item map to understand the coverage of each facet across the latent continuum (θ).

Classical Test Theory–Based Analysis

Reliability To estimate each facet's internal consistency reliability, first we tested tau-equivalence, which assumes factor loading of each item to be equal (Novick & Lewis, 1967). We reported Cronbach's α coefficient when the tau-equivalence was true. In case of assumption violation and for the entire multi-faceted FFMQ-B, we reported a tau-equivalence assumption-free coefficient, McDonald's ω_t, which also provided a better estimate for multi-faceted scales (Cho, 2016; Dunn et al., 2014; Kalkbrenner, 2021).

Structural Validity To assess structural validity, we tested four latent structures: (i) Model 1: five-facet model, (ii) Model 2: five-facet model (excluding *Observe*), (iii) Model 3: one-factor higher-order model, and (iv) Model 4: two-factor higher-order model. Models 1, 2, and 3 were assessed using both CFA (WSMV estimator; polychoric correlation) and ESEM (maximum likelihood estimator) techniques. Model 4 was assessed using only ESEM since the proposed model indicated substantial cross-loading of the facets (Tran et al., 2013). In ESEM, we used factor scores for estimating the high-order models: Models 3 and 4 (Hancock & Mueller, 2006; Tran et al., 2013). To assess

Summary Descriptives (n=532)

	Summary Statistics				Graphics	Response Pattern				
Items	Mean	SD	SW[1]	Item-Total Correlation	Density	Never or very rarely true[2]	Often true[2]	Rarely true[2]	Sometimes true[2]	Very often or always true[2]
Observe										
item01	3.51	1.20	0.89*	0.35		7.89% (42)	27.07% (144)	11.09% (59)	28.76% (153)	25.19% (134)
item06	3.20	1.34	0.90*	0.41		15.04% (80)	22.37% (119)	15.60% (83)	25.56% (136)	21.43% (114)
item11	3.18	1.19	0.91*	0.47		10.15% (54)	29.51% (157)	18.80% (100)	27.63% (147)	13.91% (74)
item15	3.34	1.26	0.90*	0.44		10.34% (55)	25.75% (137)	15.04% (80)	27.07% (144)	21.80% (116)
item20	3.75	1.19	0.86*	0.49		6.58% (35)	30.83% (164)	9.02% (48)	20.49% (109)	33.08% (176)
item26	4.14	0.89	0.80*	0.44		1.69% (9)	42.29% (225)	3.01% (16)	13.91% (74)	39.10% (208)
item31	3.58	1.08	0.89*	0.51		5.08% (27)	35.90% (191)	9.59% (51)	28.76% (153)	20.68% (110)
item36	3.69	1.00	0.88*	0.61		3.38% (18)	42.11% (224)	8.08% (43)	25.56% (136)	20.86% (111)
Describe										
item02	3.40	1.12	0.89*	0.60		5.64% (30)	21.43% (114)	12.22% (65)	39.47% (210)	21.24% (113)
item07	3.45	1.16	0.90*	0.62		7.14% (38)	30.26% (161)	12.59% (67)	28.95% (154)	21.05% (112)
item12	3.13	1.28	0.89*	0.37		9.40% (50)	14.47% (77)	26.13% (139)	28.20% (150)	21.80% (116)
item16	3.01	1.20	0.91*	0.48		9.59% (51)	18.61% (99)	28.01% (149)	29.14% (155)	14.66% (78)
item22	3.25	1.24	0.90*	0.40		8.08% (43)	24.25% (129)	23.12% (123)	24.44% (130)	20.11% (107)
item27	3.13	1.30	0.90*	0.52		15.04% (80)	27.26% (145)	16.92% (90)	24.62% (131)	16.17% (86)
item32	3.58	1.06	0.89*	0.60		4.14% (22)	34.96% (186)	10.15% (54)	29.89% (159)	20.86% (111)
item37	3.34	1.17	0.90*	0.49		7.14% (38)	33.83% (180)	19.17% (102)	22.93% (122)	16.92% (90)
Act with Awareness										
item05	2.58	1.16	0.90*	0.33		18.42% (98)	11.65% (62)	33.46% (178)	28.20% (150)	8.27% (44)
item08	3.41	1.25	0.88*	0.31		5.08% (27)	18.80% (100)	22.74% (121)	25.94% (138)	27.44% (146)
item13	2.93	1.24	0.91*	0.38		14.10% (75)	21.80% (116)	25.75% (137)	25.75% (137)	12.59% (67)
item18	3.24	1.14	0.91*	0.37		5.64% (30)	27.26% (145)	22.93% (122)	28.76% (153)	15.41% (82)
item23	3.36	1.16	0.90*	0.26		4.89% (26)	26.50% (141)	21.24% (113)	27.26% (145)	20.11% (107)
item28	3.35	1.19	0.91*	0.43		6.95% (37)	23.50% (125)	17.11% (91)	31.39% (167)	21.05% (112)
item34	3.50	1.21	0.88*	0.33		4.14% (22)	21.43% (114)	19.55% (104)	26.69% (142)	28.20% (150)
item38	2.59	1.16	0.89*	0.12		16.35% (87)	11.65% (62)	37.59% (200)	25.56% (136)	8.83% (47)
Nonjudge										
item03	2.22	1.17	0.85*	0.34		32.89% (175)	9.21% (49)	32.71% (174)	19.36% (103)	5.83% (31)
item10	2.81	1.11	0.90*	0.02		9.96% (53)	14.66% (78)	33.08% (176)	32.52% (173)	9.77% (52)
item14	2.77	1.28	0.90*	0.13		17.11% (91)	15.04% (80)	31.39% (167)	22.93% (122)	13.53% (72)
item17	1.67	0.97	0.70*	0.44		61.65% (328)	2.63% (14)	16.17% (86)	17.86% (95)	1.69% (9)
item25	2.69	1.10	0.91*	0.06		14.10% (75)	14.85% (79)	31.02% (165)	33.27% (177)	6.77% (36)
item30	2.63	1.21	0.90*	0.12		19.17% (102)	14.29% (76)	31.39% (167)	25.75% (137)	9.40% (50)
item35	2.69	1.18	0.90*	0.21		15.60% (83)	13.53% (72)	33.08% (176)	28.01% (149)	9.77% (52)
item39	2.37	1.12	0.88*	0.46		23.50% (125)	12.41% (66)	38.35% (204)	20.86% (111)	4.89% (26)
Nonreact										
item04	3.34	1.13	0.90*	0.23		8.27% (44)	30.83% (164)	11.65% (62)	33.46% (178)	15.79% (84)
item09	3.33	1.15	0.91*	0.53		7.71% (41)	32.89% (175)	15.79% (84)	28.01% (149)	15.60% (83)
item19	3.70	1.05	0.87*	0.50		4.32% (23)	40.41% (215)	8.27% (44)	23.87% (127)	23.12% (123)
item21	3.29	1.18	0.90*	0.38		9.40% (50)	33.83% (180)	15.79% (84)	25.94% (138)	15.04% (80)
item24	3.35	1.16	0.90*	0.38		8.46% (45)	35.34% (188)	14.85% (79)	25.56% (136)	15.79% (84)
item29	3.05	1.03	0.91*	0.28		7.71% (41)	28.20% (150)	20.49% (109)	37.03% (197)	6.58% (35)
item33	3.22	1.07	0.91*	0.31		7.14% (38)	29.70% (158)	16.35% (87)	35.53% (189)	11.28% (60)

[1] *Shapiro–Wilk test; p<0.001*

[2] **%(n)**

Fig. 2 Summary descriptive statistics and response pattern observed in the large-scale survey. All items violated the normality assumption

Table 2 Unidimensionality of each mindfulness facet ($n = 532$)

	χ^2	*df*	*CFI*	*TLI*	*RMSEA* (90% CI)	*SRMR*
Observe	71.65*	20	0.98	0.98	0.07 (0.05–0.09)	0.05
Describe	416.34*	20	0.91	0.88	0.19 (0.18–0.021)	0.12
Describe (modified)	36.55*	17	0.99	0.99	0.05 (0.03–0.07)	0.04
Actaware	85.18*	20	0.98	0.98	0.08 (0.06–0.10)	0.05
Nonjudge	173.89*	20	0.86	0.80	0.12 (0.10–0.14)	0.10
Nonjudge (modified)	28.86*	8	0.98	0.95	0.07 (0.04–0.10)	0.05
Nonreact	55.31*	14	0.96	0.94	0.07 (0.05–0.10)	0.05

*$p < 0.001$; *df*, degrees of freedom; *CFI*, comparative fit index; *TLI*, Tucker-Lewis index; *RMSEA*, root mean square error of approximation; *SRMR*, standardized root mean square residual

the model fit, we followed the aforementioned guideline of Hu and Bentler (1999). We have also reported the internal consistency reliability estimate McDonald's ω_t for the entire scale.

Concurrent Validity

We gathered concurrent validity evidence for each facet by calculating their Pearson product-moment correlation coefficients with emotional intelligence, MAAS, depression and neuroticism, and openness to experience using our subset of the sample ($n = 254$).

Results

Content Validity, Descriptive Statistics, and Reliability

To check for the content validity of the scale, we calculated the I-CVI scores for all items. The results showed that all I-CVI scores were > 0.83, and the S-CVI was 0.96, indicating good content validity (Lynn, 1986; Polit et al., 2007).

Figure 2 summarizes univariate descriptive statistics for the 39 items of BBFQ. Normality assumption was

Table 3 Item fit statistics of the five fitted models (39 items; $n = 532$)

Items	S-χ^2	*df*	*p*	*RMSEA*	Items	S-χ^2	*df*	*p*	*RMSEA*
Observe					Actaware				
item1	95.75	65.00	0.03	0.01	item34r	79.43	49.00	0.03	0.00
item6	114.68	60.00	0.04	0.00	item38r	162.79	76.00	0.05	0.00
					Nonjudge				
item11	146.39	55.00	0.06	0.00	item3r	81.54	60.00	0.03	0.03
item15	135.62	59.00	0.05	0.00	item10r	87.35	51.00	0.04	0.00
item20	115.41	57.00	0.04	0.00	item14r	155.64	51.00	0.06	0.00
item26	91.58	41.00	0.05	0.00	item17r	74.76	43.00	0.04	0.00
item31	75.78	53.00	0.03	0.02	item25r	53.37	49.00	0.01	0.31
item36	89.56	41.00	0.05	0.00	item30r	109.84	48.00	0.05	0.00
Describe					item35r	124.39	56.00	0.05	0.00
item2	165.69	52.00	0.06	0.00	item39r	95.29	59.00	0.03	0.00
item7	142.75	53.00	0.06	0.00	Nonreact				
item12r	119.65	63.00	0.04	0.00	item4	109.15	52.00	0.05	0.00
item16r	125.36	60.00	0.05	0.00	item9	85.58	52.00	0.03	0.00
item22r	106.63	65.00	0.03	0.00	item19	94.79	46.00	0.04	0.00
item27	116.73	61.00	0.04	0.00	item23r	96.69	51.00	0.04	0.00
item32	99.25	51.00	0.04	0.00	item28r	129.65	52.00	0.05	0.00
item37	120.31	63.00	0.04	0.00	item29	102.82	47.00	0.05	0.00
Actaware					item33	101.75	51.00	0.04	0.00
item5r	117.53	56.00	0.05	0.00					
item8r	150.42	55.00	0.06	0.00					
item13r	108.42	55.00	0.04	0.00					
item18r	91.73	58.00	0.03	0.00					
item21	106.25	48.00	0.05	0.00					
item24	110.44	44.00	0.05	0.00					

df, degrees of freedom; *S-*χ^2, signed chi-square; *RMSEA*, root mean square error of approximation; the designation "r" after an item number means that item is reverse scored

violated for all items ($p < 0.001$) (Shapiro & Wilk, 1965). The corrected item-total correlations (Fig. 2) for the five facets were *Observe*: 0.44–0.67; *Describe*: 0.50–0.66; *Actaware*: 0.23–0.68; *Nonjudge*: 0.25–0.56; and *Nonreact*: 0.41–0.57.

In the subset of our sample ($n = 254$), the internal consistency reliability coefficient McDonald's ω_t for the Bangla MAAS, EI, Depression Scale, Neuroticism, and Openness were 0.89, 0.89, 0.94, 0.75, and 0.73, respectively.

Item Response Theory–Based Item Analysis

Unidimensionality

The unidimensionality of each facet of FFMQ-B was assessed through categorical CFA. Table 2 summarizes the model fit of each facet. All fitted models exhibited a significant χ^2 statistic. However, χ^2 statistic is known for its sensitivity toward sample size (Brown, 2015, pp. 62–76). More emphasis was given to other fit indices. *Observe* and *Actaware* facets yielded good fit. An acceptable fit was observed for the *Nonreact* facet. Both *Describe* and *Nonjudge* facets required post hoc model modification (covary of error variance between item pairs: *Describe*—12–22, 12–16, 16–22; *Nonjudge*—14–17) to achieve a good model fit.

Item Analysis

Table 3 presents the item-fit indices for each of the five facets. We discarded two items exhibiting bad fit (Item 2 from *Describe*, 14 from *Nonjudge*; $RMSEA > 0.06$) and refitted the revised models. In the refitted *Describe* facet, 2 more items (Items 12 and 16 from *Describe*; $RMSEA > 0.06$; Table S1 in the Supplementary Information) appeared to be a misfit and thus discarded. Table S2 in the Supplementary Information summarizes the item discrimination and difficulty parameters of the remaining 35 items. All items except 38 (*Actaware*) and 39 (*Nonjudge*) were within the suggested limit of item discrimination. OCCs (Fig. S1 in the Supplementary Information) showed that all items had one non-increasing (P1), one non-decreasing (P5), and three unimodal (P2–P4) item difficulty threshold curves except Items 3, 17, and 39 from *Nonjudge*; 22 from *Describe*; and 38 from *Actaware* facets. Figure 3 a depicts one of the item-OCCs (Item 26) that we considered non-problematic. Figure 3 b–f depicts the 5 items with problematic OCCs.

We identified 5 items (Items 3 and 39 from *Nonjudge*, 4 from *Nonreact*, 22 from *Describe*, 38 from *Actaware*) with relatively flat curves ($I(\theta) < 0.20$; see Fig. 4), thus excluded from the scale. Thus, from the fitted 35 items, 6 items were further discarded for being outside the suggested item

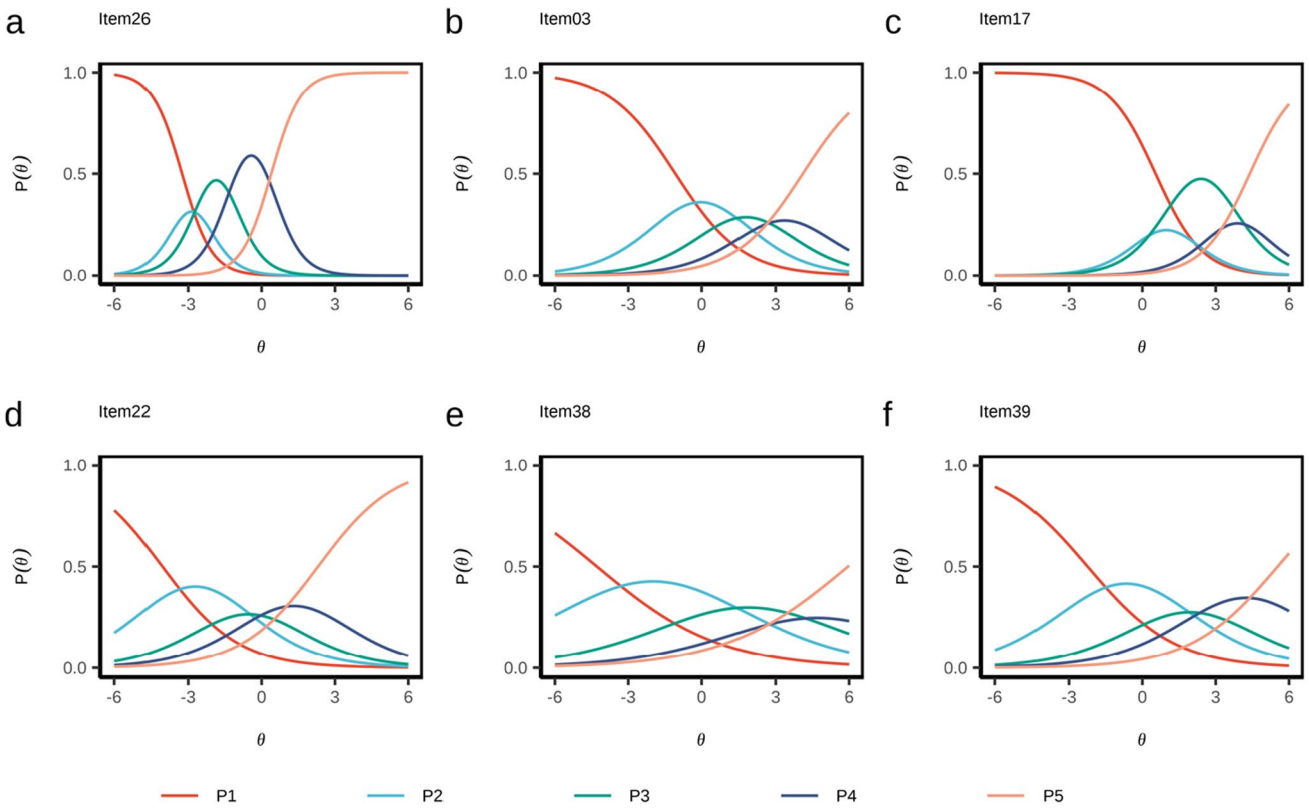

Fig. 3 Item characteristics curve. **a** presents representative accepted ICC. **b–f** indicate problematic ICCs

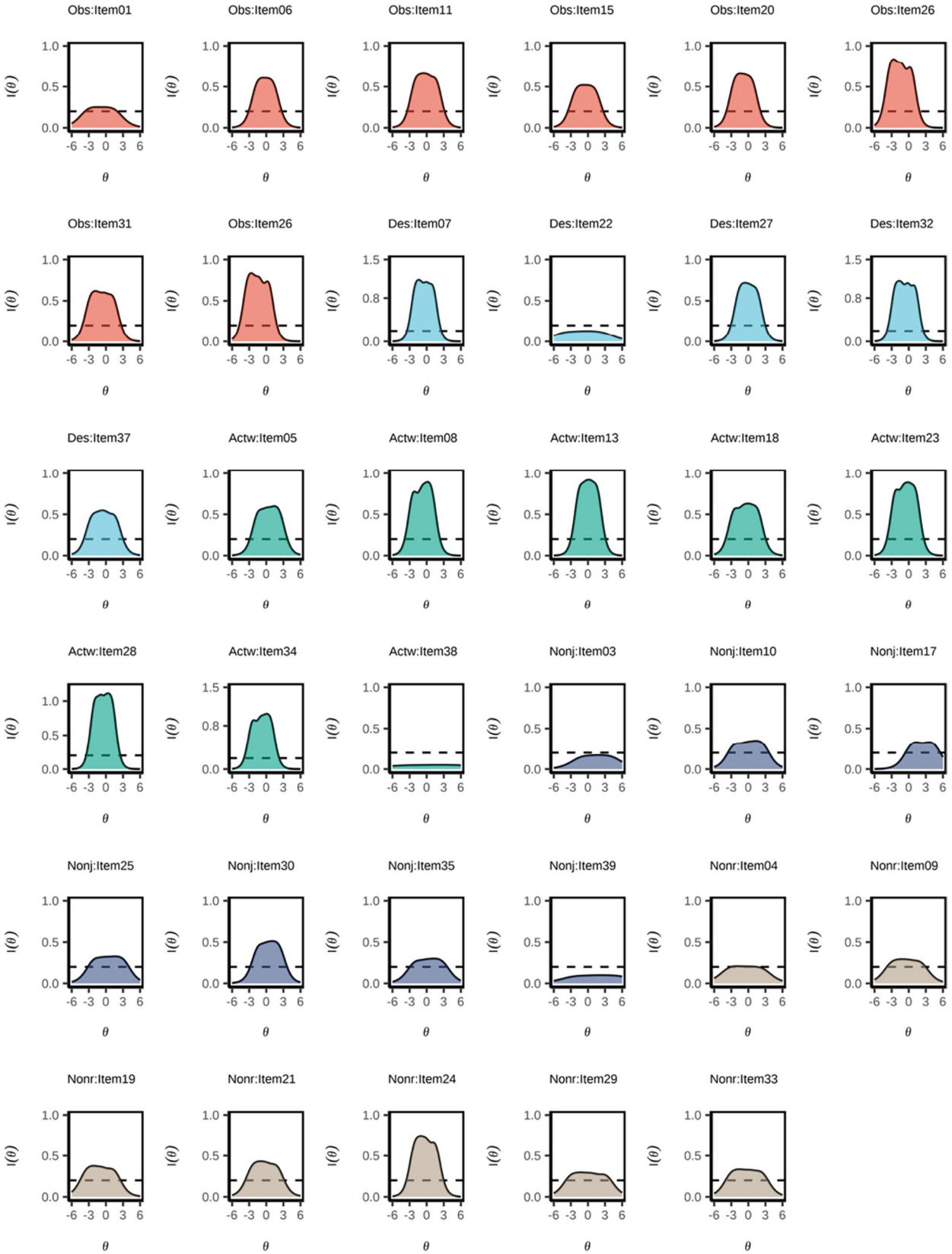

Fig. 4 Item information curve for the 35 items of FFMQ-B. Items 3, 4, 22, 38, and 39 exhibited relatively flat curves ($I(\theta) < 0.20$)

discrimination guidelines, inappropriate monotonicity and/or relatively flat information curve (Items 3, 17, and 39 from *Nonjudge*; 4 from *Nonreact*; 22 from *Describe*; and 38 from *Actaware*) and refitted the revised models with the retained 29 items (*Observe*: 8 items; *Describe*: 4 items; *Actaware*: 7 items; *Nonreact*: 6 items; *Nonjudge*: 4 items). Table 4 summarizes the IRT parameters of the remaining 29 items. Eleven items had moderate discrimination, 11 had high discrimination, and 7 items had very high discrimination scores.

Person fit indicates the validity and meaningfulness of the fitted model at the participants' latent trait level (Desjardins & Bulut, 2018). We estimated the person fit statistics using the standardized fit index, Z_h statistics (Drasgow et al., 1985). Figure 5 indicates that for all five revised models, Z_h statistics are larger than −2 for most participants, suggesting a good person fit.

Test information curves (TIC) for the revised models with 29 items (Fig. 6) indicated that each facet had a good range of coverage across the underlying traits. For the *Observe*, *Describe*, *Actaware*, and *Nonreact* facets, the highest level of information and least amount of errors were observed across θ range −3 to 2. For the *Nonjudge* facet, it was −2 to 3. The empirical reliability estimates of the five facets were *Observe* = 0.82, *Describe* = 0.76, *Actaware* = 0.84, *Nonjudge* = 0.64, and *Nonreact* = 0.70.

Table 4 Item discrimination (a) and item difficulty thresholds (b1–b4) of the five fitted models (29 items; $n = 532$)

	a	b1	b2	b3	b4	S-χ^2	*df*	*RMSEA*	*p*
Observe									
item1	0.90	−3.09	−1.85	−0.12	1.41	95.75	65.00	0.03	0.01
item6	1.39	−1.62	−0.77	0.26	1.25	114.68	60.00	0.04	0.00
item11	1.47	−1.95	−0.81	0.24	1.66	146.39	55.00	0.06	0.00
item15	1.29	−2.10	−1.06	0.09	1.25	135.62	59.00	0.05	0.00
item20	1.45	−2.38	−1.54	−0.53	0.65	115.41	57.00	0.04	0.00
item26	1.66	−3.25	−2.47	−1.24	0.39	91.58	41.00	0.05	0.00
item31	1.43	−2.66	−1.63	−0.26	1.23	75.78	53.00	0.03	0.02
item36	1.89	−2.58	−1.62	−0.44	1.07	89.56	41.00	0.05	0.00
Describe									
item7	2.02	−1.95	−1.13	−0.04	1.07	72.99	21.00	0.07	0.00
item27	1.52	−1.58	−0.72	0.23	1.48	35.62	24.00	0.03	0.06
item32	1.90	−2.39	−1.41	−0.17	1.11	43.02	19.00	0.05	0.00
item37	1.31	−2.46	−1.04	−0.03	1.58	41.45	23.00	0.04	0.01
Actaware									
item5r	1.39	−1.44	0.03	1.31	2.24	126.97	52.00	0.05	0.00
item8r	1.68	−2.38	−0.82	0.15	0.85	100.83	50.00	0.04	0.00
item13r	1.73	−1.51	−0.38	0.53	1.61	96.48	52.00	0.04	0.00
item18r	1.42	−2.54	−0.89	0.27	1.59	109.87	51.00	0.05	0.00
item23r	1.72	−2.36	−0.91	0.07	1.17	100.58	49.00	0.04	0.00
item28r	1.96	−1.97	−0.90	0.15	1.04	109.86	49.00	0.05	0.00
item34r	1.84	−2.41	−1.01	−0.03	0.77	89.21	46.00	0.04	0.00
Nonjudge									
item10r	1.26	−2.17	−0.26	1.16	2.20	37.47	24.00	0.03	0.04
item25r	1.46	−1.66	−0.19	1.17	2.32	64.47	22.00	0.06	0.00
item30r	1.32	−1.40	0.05	1.17	2.18	39.09	24.00	0.03	0.03
item35r	0.84	−2.27	−0.10	1.59	2.95	43.70	27.00	0.03	0.02
Nonreact									
item9	0.87	−3.19	−1.55	0.08	2.22	73.22	46.00	0.03	0.01
item19	1.14	−3.22	−2.11	−0.66	1.30	117.64	42.00	0.06	0.00
item21	1.25	−2.26	−1.12	0.05	1.76	87.09	41.00	0.05	0.00
item24	1.62	−2.02	−1.06	−0.06	1.47	100.76	36.00	0.06	0.00
item29	0.95	−2.99	−1.19	0.73	3.16	83.01	42.00	0.04	0.00
item33	1.05	−2.85	−1.38	0.37	2.30	94.61	43.00	0.05	0.00

df, degrees of freedom; *S-*χ^2, signed chi-square; *b1*, latent trait required to pass from 1 to higher; *b2*, latent trait required to pass from 2 to higher; *b3*, latent trait required to pass from 3 to higher; *b4*, latent trait required to pass from 4 to higher; *RMSEA*, root mean square error of approximation; the designation "r" after an item number means that item is reverse scored

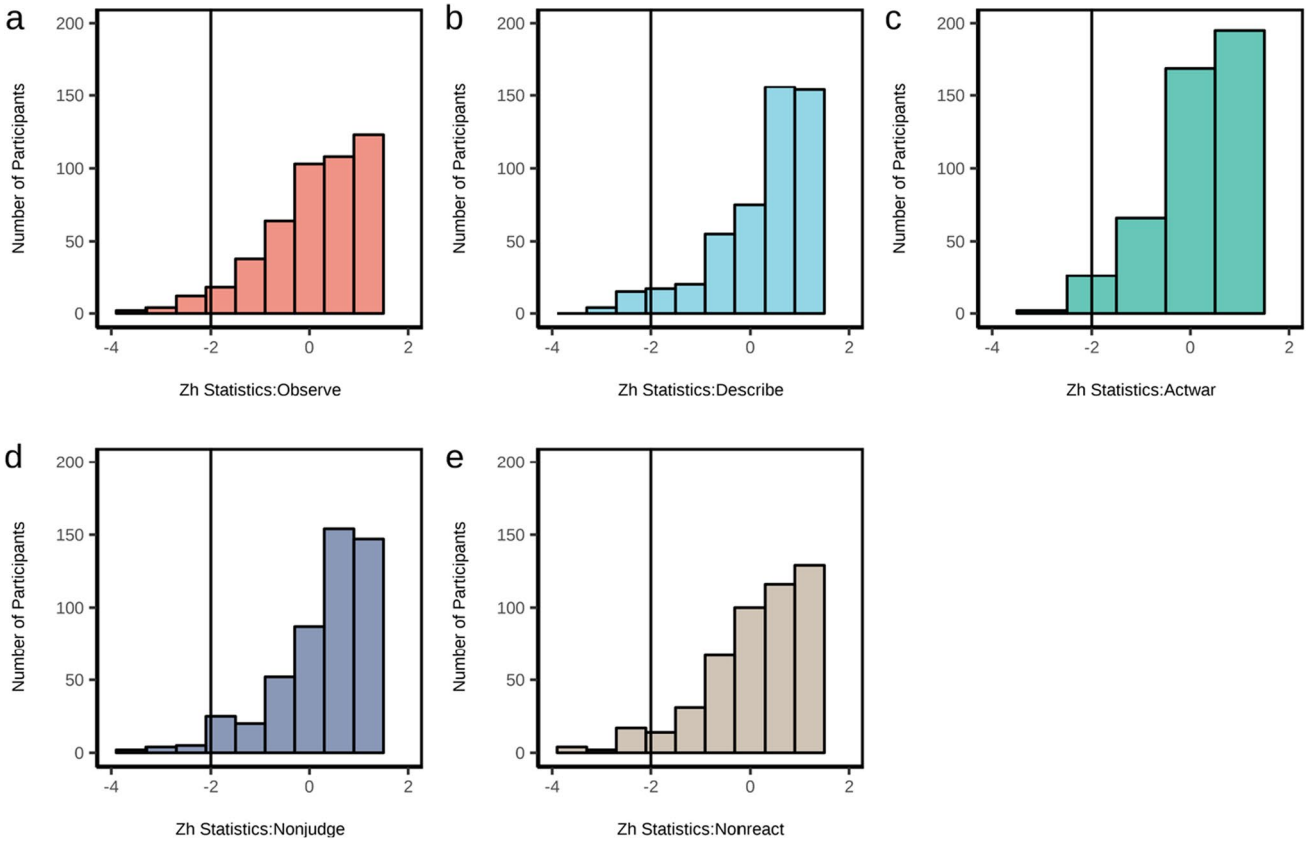

Fig. 5 Person fit of the five fitted models **a** *Observe*, **b** *Describe*, **c** *Actaware*, **d** *Nonjudge*, and **e** *Nonreact*. Z_h statistics are larger than −2 for most participants for all fitted models

Figure 7 depicts the person-item map for all five facets. This map illustrates the distribution of the person's ability in relation to item difficulty using the same metric logit units. The distribution of person thresholds appeared approximately normally distributed and covered a good range of respondents' underlying mindfulness traits across five facets.

Classical Test Theory–Based Analysis: Reliability and Structural Validity

The tau-equivalence assumption was violated for all facets ($p < 0.001$) except nonjudge ($p = 0.51$). Hence, we estimated McDonald's ω_t coefficient for *Observe*, *Describe*, *Actaware*, and *Nonreact*, and Cronbach's α coefficient based on polychoric correlation for the *Nonjudge* facet. The five facets of FFMQ exhibited moderate to satisfactory reliability (McDonald's ω_t: *Observe* = 0.80; *Describe* = 0.76, *Actaware* = 0.84; *Nonreact* = 0.67; Cronbach's α: *Nonjudge* = 0.63).

Table 5 presents the four fitted model fits obtained from CFA and ESEM. CFA indicated Model 1 (five-facet model) and Model 2 (four-facet model excluding Observe) attained an acceptable fit (Model 1: *CFI* = 0.94, *TLI* = 0.94; Model 2: *CFI* = 0.94, *TLI* = 0.93) and exhibited satisfactory reliability for the entire scale (*McDonald's* ω_t = 0.80 and 0.86). However, Model 3: one-factor higher-order model, exhibited poor fit on the retained 29 items. We only observed an acceptable fit after allowing the error variance of *Actaware* and *Nonjudge* facets to covary (*CFI* = 0.93, *TLI* = 0.93, *RMSEA* = 0.08, *SRMR* = 0.08). Hence, we rejected Model 3.

ESEM analyses indicated Model 1 exhibited good fit (*CFI* = 0.99, *TLI* = 0.99, *RMSEA* = 0.03, *SRMR* = 0.04) and satisfactory reliability (*McDonald's* ω_t for entire scale = 0.87). Model 2 also exhibited acceptable to good fit and satisfactory reliability (*CFI* = 0.95, *TLI* = 0.92, *RMSEA* = 0.05, *SRMR* = 0.04; *McDonald's* ω_t = 0.84). However, model fit indices were better for Model 1 compared to Model 2. Thus, we accept a Model 1–correlated five-facet structure. Similar to CFA, ESEM also indicated a poor fit for Model 3. Lastly, an acceptable model fit was observed for Model 4: two-factor higher-order model (*CFI* = 0.99, *TLI* = 0.90, *SRMR* = 0.03; *McDonald's* ω_t for entire scale = 0.78). The *RMSEA* value for Model 4 was just over the border of the guidelines (0.09). Given the nature of ESEM spuriously inflating the *RMSEA* since it estimates many parameters, we considered the *RMSEA* value acceptable (Marsh et al., 2010; Tran et al., 2013).

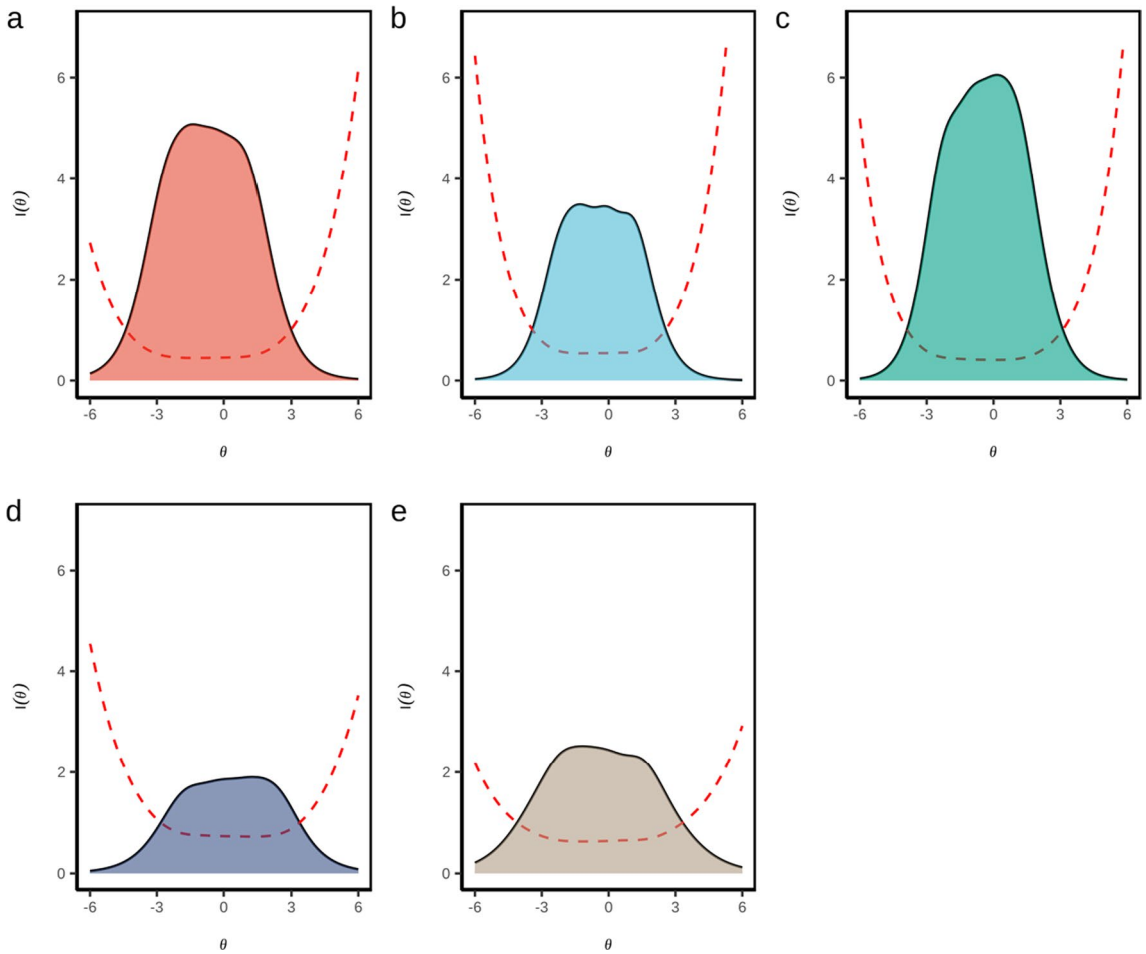

Fig. 6 Test information curves: **a** *Observe* (8 items), **b** *Describe* (4 items), **c** *Actaware* (7 items), **d** *Nonjudge* (4 items), **e** *Nonreact* (6 items). TICs covered a substantial range of θ

Table 6 presents the factor loadings of Models 1, 3, and 4. In CFA-based Model 1, all factor loadings were significant and > 0.50. ESEM-based model 1 indicated that all items had the highest factor-loading on their corresponding facets except for Items 9, 31, and 35. CFA-based modified Model 3 indicated *Actaware* facet loaded poorly on

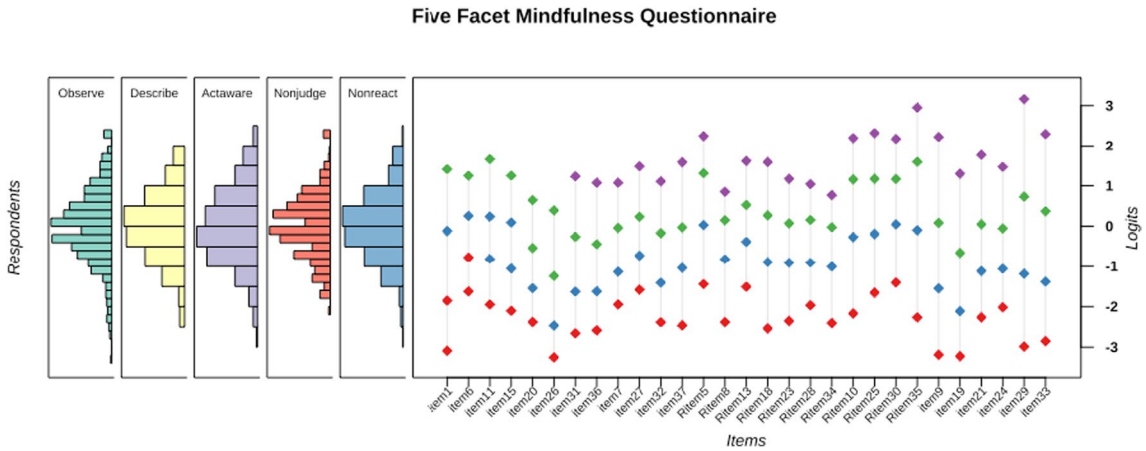

Fig. 7 The person-item map. Items' difficulty thresholds are dispersed and cover a good range of respondents' underlying mindfulness traits across five facets

Table 5 Confirmatory factor analysis and exploratory structural equation modeling–based model fit of Bangla Five Factor Mindfulness Questionnaire (29 items; $n = 532$)

Model	χ^2	*df*	*CFI*	*TLI*	*RMSEA* (90% CI)	*SRMR*	McDonald's ω_t
Confirmatory factor analysis							
M1: five-facet model	1325.68*	367	0.94	0.94	0.07 (0.07–0.07)	0.07	0.80
M2: four-facet model (without *Observe*)	713.405*	183	0.94	0.93	0.07 (0.07–0.08)	0.07	0.86
M3: one-factor higher-order model	2300.63*	372	0.88	0.87	0.10 (0.09–0.10)	0.09	0.80
M4: modified one-factor higher-order model	1499.33*	371	0.93	0.93	0.08 (0.07–0.08)	0.08	0.80
Exploratory structure equation modeling							
M1: five-facet model	379.11*	271	0.99	0.99	0.03 (0.02–0.03)	0.04	0.87
M2: four-facet model (without *Observe*)	338.58*	132	0.95	0.92	0.05 (0.06–0.07)	0.04	0.84
M3: one-factor higher-order model	119.25*	5	0.71	0.42	0.21 (0.18–0.24)	0.11	0.54
M4: two-factor higher-order model	4.99*	1	0.99	0.90	0.09 (0.02–0.17)	0.03	0.78

*$p < 0.001$; *df*, degrees of freedom; *CFI*, comparative fit index; *TLI*, Tucker-Lewis index; *RMSEA*, root mean square error of approximation; *SRMR*, standardized root mean square residual

the higher-order factor mindfulness, whereas the *Observe* facet indicated non-significant poor loading in the ESEM-based Model 3. ESEM-based Model 4 indicated *Observe*, and *Nonreact* facets loaded highly on self-regulated attention component. *Describe*, *Actaware*, and *Nonjudge* highly loaded on orientation to experience. However, the correlation of these two higher-order factors was low ($r = -0.01$, $p = 0.91$).

Concurrent Validity

We gathered concurrent validity evidence for FFMQ-B on a subset of our sample ($n = 254$). Table 7 presents the inter-correlation of the five facets as well as correlations with EI (Hyde et al., 2002), depression (Uddin & Rahman, 2005), MAAS: a measure of mindfulness (Brown & Ryan, 2003), and two measures of personality: openness and neuroticism (John et al., 1991). The inter-correlations of the five facets were modest and significant (except for three pairs: *Observe-Actaware*, *Describe-Nonjudge*, and *Nonreact-Actaware*). All five facets (except *Nonjudge*) exhibited positive correlations with MAAS, EI, and openness to experience and negative correlations with depression and neuroticism. Openness to experience exhibited the highest correlation with the *Observe* facet. EI exhibited the highest correlation with both *Describe* and *Actaware* facets. MAAS showed the highest correlation with *Actaware* and weak correlations with *Nonreact* and *Nonjudge*.

Discussion

Recent years have witnessed an increase in mindfulness-based interventions and therapies in mental health care practices (Chin et al., 2019; MacKenzie et al., 2018; Sumantry & Stewart, 2021). FFMQ facilitates those interventions by providing a holistic assessment of mindfulness among clients. Due to the absence of a locally developed mindfulness scale in Bangladesh, we aimed to translate the FFMQ into Bangla (FFMQ-B) and psychometrically validate it on a Bangladeshi community sample. We found the factor structure and concurrent validity of FFMQ-B to be consistent with the existing literature (Baer et al., 2006; Deng et al., 2014; Sugiura et al., 2012; Taylor & Millear, 2016; Tran et al., 2013).

The study had four specific objectives. First, we wanted to translate the FFMQ into Bangla, and we did it following the International Test Commission guidelines. Second, we aimed to check the precision of items making the FFMQ-B using IRT-based item analysis. We employed the graded response-based IRT models (Samejima, 1970) to analyze the item quality to increase the accuracy of the mindfulness assessment. In this process, we discarded 10 items that exhibited a bad fit with the scale, carried very little information, were outside the item-discrimination guidelines, and had a non-ideal option characteristics curve. The reduction of item numbers was also observed in earlier validation studies for FFMQ (Lilja et al., 2011; Ramos et al., 2018; Tran et al., 2013). For example, Lilja et al. (2011) excluded 10 items to increase the psychometric quality of their Swedish-translated FFMQ. Ramos et al. (2018) deleted 13 items from the Portuguese-translated FFMQ to form a more valid scale. Tran et al. (2013) observed a poor model fit with all 39 items of their German version. Hence, they excluded 19 items to construct a shortened scale with only 20 items. In this study, test information curves and person-item maps of the revised models with 29 items revealed that all facets had a substantial range of coverage across the underlying mindfulness with disparaged item difficulty thresholds. The empirical reliability estimates of the five sub-scales were satisfactory (> 0.70) except for the *Nonjudge* facet. The person-item map indicated that the response distributions across the five subscales were approximately normal and adequately covered the underlying mindfulness traits.

Table 6 Item loadings of the five-facet model, one- and two-factor higher-order model (29 items; $n = 532$)

Items	Model 1 Five-factor model ESEM (CFA)					Model 3 One-factor higher-order model ESEM (CFA: modified)		
	Observe	Describe	Actaware	Nonjudge	Nonreact	Facets	Mindfulness	
Observe						**Observe**	0.07† (0.90)	
item1	**0.59** (0.46)	−0.16	−0.02	0.15	0.09	**Describe**	0.95 (0.78)	
item6	**0.68** (0.59)	−0.09	−0.11	0.16	0.11	**Actaware**	0.63 (0.18)	
item11	**0.68** (0.62)	−0.14	0.03	0.05	0.14	**Nonjudge**	0.65 (−0.49)	
item15	**0.52** (0.57)	0.10	0.04	−0.01	−0.01	**Nonreact**	−0.16 (0.88)	
item20	**0.38** (0.62)	0.19	0.19	−0.32	0.01			
item26	**0.45** (0.67)	0.24	0.11	−0.43	−0.09	**Model 4 Two-factor higher-order model ESEM**		
item31	0.29 (0.63)	**0.46**	0.001	−0.18	−0.06	**Facets**	Orientation To experience	Self-regulated attention
item36	**0.65** (0.76)	0.08	0.14	−0.10	0.06	**Observe**	0.01†	**0.96**
Describe						**Describe**	**0.96**	−0.02
item7	0.04	**0.61** (0.74)	0.03	0.06	0.21	**Actaware**	**0.62**	0.29
item27	0.11	**0.47** (0.64)	−0.10	0.07	0.20	**Nonjudge**	**0.64**	0.01†
item32	0.12	**0.66** (0.73)	0.03	0.11	0.03	**Nonreact**	−0.23	**0.38**
item37	0.25	**0.42** (0.62)	−0.07	0.07	0.04			
Actaware								
item5r	0.04	0.04	**0.46** (0.65)	0.32	0.17			
item8r	0.12	−0.01	**0.55** (0.69)	0.26	0.12			
item13r	0.02	−0.03	**0.57** (0.72)	0.32	0.02			
item18r	0.02	0.22	**0.52** (0.63)	0.07	−0.011			
item23r	−0.10	−0.06	**0.76** (0.67)	−0.07	0.03			
item28r	0.07	−0.00	**0.74** (0.74)	−0.03	0.08			
item34r	0.04	−0.07	**0.91** (0.71)	−0.27	−0.10			
Nonjudge								
item10r	−0.28	0.24	0.12	**0.37** (0.53)	−0.08			
item25r	−0.12	0.08	0.25	**0.35** (0.52)	−0.22			
item30r	−0.02	−0.12	0.21	**0.42** (0.62)	−0.24			
item35r	−0.45	0.15	0.05	0.14 (0.52)	−0.10			
Nonreact								
item9	0.38	0.14	0.15	−0.13	0.08 (0.62)			
item19	0.25	0.09	0.24	−0.02	**0.32** (0.60)			
item21	−0.09	−0.01	0.18	−0.12	**0.67** (0.45)			
item24	−0.01	0.10	0.012	−0.05	**0.57** (0.51)			
item29	0.12	0.12	−0.15	0.03	**0.32** (0.42)			
item33	0.01	0.26	−0.22	−0.07	**0.43** (0.51)			

All loadings in the CFA-based Model 1 and Model 2 are significant ($p < 0.001$) except the loading identified with "†." For ESEM loadings, highest loadings for the items across the facets are in bold; the designation "r" after an item number means that item is reverse scored

As for our third objective, we provided evidence for the structural validity of the FFMQ-B using categorical CFA and ESEM techniques and estimated the scale reliability. The results of the categorical CFA and ESEM supported the multi-facet concept of mindfulness and replicated the five-facet model (Model 1) obtained by Baer et al. (2006) with satisfactory internal consistency for the entire scale (McDonald's $\omega = 0.80$). However, the one-factor higher-order model (Model 3) exhibited poor fit in our community sample. After introducing a post hoc modification to the model, we observed an acceptable fit. The *Actaware* facet did not show satisfactory factor loading; hence, we rejected this model (Model 3). The results of ESEM analyses provided evidence of a two-factor higher-order model (Model 4), which is compatible with the two-component model of mindfulness: (a) self-regulated attention and (b) orientation to experience (Bishop et al., 2004). *Observe* and *Nonreact* facets loaded highly on the self-regulated attention component. *Describe*, *Actaware*, and *Nonjudge* are highly loaded on orientation to experience. However, we observed a negligible correlation between the two higher-order factors ($r = -0.01$, $p = 0.91$) — attention and orientation to experience. We expected it

Table 7 Correlation of emotional intelligence (EI), depression, MAAS, openness, and neuroticism with the five facets of mindfulness ($n = 254$)

	Observe	Describe	Actaware	Nonjudge	Nonreact
Inter-facet correlation					
Observe					
Describe	0.**54****				
Actaware	0.05	**0.20****			
Nonjudge	−0.33**	−0.11	0.**39****		
Nonreact	0.**54****	0.49**	0.10	−0.26**	
Predicted positive correlations					
EI	0.37*	**0.45****	**0.45****	−0.02	0.39**
MAAS	0.16**	0.26**	**0.63****	0.24**	0.17**
Openness	0.**20****	0.13*	0.01	−0.12*	0.18**
Predicted negative correlations					
Depression	−0.05	−0.13*	**−0.48****	−0.15*	−0.10
Neuroticism	−0.18**	−0.29**	**−0.55****	−0.20**	−0.36**

In each row, the largest correlations are shown in bold. $^{**}p < 0.001$; $^{*}p < 0.05$

since increased self-regulated attention does not necessarily lead to increased openness and vice versa (Cardaciotto et al., 2008). Tran et al. (2013) also reported a similar two-factor higher-order model in a community sample where *Actaware* and *Nonjudge* loaded highest on orientation to experience; *Observe* and *Nonreact* loaded highest on self-regulated attention; and *Describe* loaded almost equally on both components.

We observed satisfactory reliability for the entire scale (≥ 0.80) and moderate to satisfactory reliability for the five facets (0.61–0.80; Isabella et al., 2014, p. 359). *Nonjudge* (0.61) and *Nonreact* (0.67) had moderate reliability estimates. Similar reliability estimates for *Nonjudge* and *Nonreact* facets were also observed in several other studies (Brazil: Barros et al., 2015; China: Deng et al., 2011; Australia: Ramos et al., 2018; Japan: Sugiura et al., 2012; Germany: Tran et al., 2013). One plausible reason behind these could be the disparities in understanding these two facets across different cultures. Also, item comprehensibility might be another contributing cause to this moderate reliability. Some items in these two facets, such as Item 29 ("When I have distressing thoughts or images, I am able just to notice them without reacting"), might appear difficult to understand and differentiate by people without any mediation experience (Tran et al., 2013). Overall, we were able to reproduce the core five-facet structure of FFMQ, which is common to most cultures (Karl et al., 2022). However, the reduction of the items reflects the individual variability caused by cultural variation in understanding the terms and concepts used in FFMQ.

Our fourth objective was to collect concurrent validity evidence for FFMQ-B. The study clearly showed that the mindfulness facets were associated with other constructs as predicted. Similar to Baer et al. (2006), all facets exhibited weak to moderate correlations among themselves. *Nonjudge* was negatively correlated with the *Observe* facet, which was compatible with the previous findings on non-meditating samples (Baer et al., 2006; Baer et al., 2008; Lilja et al., 2011). In line with our prediction, all facets (except *Nonjudge*) exhibited positive correlations with EI, openness to experience, and MAAS (Prediction 1). Depression and neuroticism were negatively correlated with all five facets (Prediction 2). Openness to experience exhibited the highest correlation with the *Observe* facet (Prediction 3). We predicted EI would show the strongest association with *Describe* (Prediction 4). The results indicated EI had the highest correlation coefficient with *Describe* and *Actaware*. Previous studies also supported similar patterns of correlations of *Describe* and *Actaware* facets with similar constructs such as emotion regulation (Giovannini et al., 2014; Sugiura et al., 2012). MAAS exhibited the strongest correlation with *Actaware* (Prediction 5) and weak correlations with *Nonjudge* and *Nonreact* (Prediction 6). Altogether, these results indicated satisfactory concurrent validity for FFMQ-B.

In summary, IRT-based item analysis on the 39-item Bangla-translated FFMQ discarded 10 items. The remaining 29 items on the scale have diverse item discrimination capabilities and offer good coverage across the underlying mindfulness traits. CFA and ESEM analyses on the 29-item scale retained a correlated five-facet latent structure (*Observe*, *Describe*, *Actaware*, *Nonjudge*, *Nonreact*). ESEM further provided evidence of a two-factor higher-order latent structure, supporting the two-component model of mindfulness (self-regulated attention and orientation to experience; Bishop et al., 2004). The 29-item scale has been reliable

and valid. Hence, we recommend that the Bangla FFMQ be used to measure the mindfulness of Bangla-speaking people, thus facilitating mindfulness-based interventions among this population.

Limitations and Future Research

We explored the latent structure of the FFMQ-B using participants recruited through convenience sampling; no participants reported practicing meditation. Further studies should recruit a randomized gender-balanced sample, including those who meditate and who do not meditate, and investigate the measurement invariance and differential item functioning across those groups. In this study, *Nonreact* and *Nonjudge* facets exhibited moderate reliability. Future studies should investigate how to improve the reliability of those facets by adding new items with better comprehensibility. Around 265 million native and non-native speakers (Eberhard et al., 2019) use four Bangla dialects — East Bangla, North Bangla, Rajbanshi, and South Bangla dialects. The current study only focused on the East Bangla dialects (Faquire, 2012); hence, any future adaptation works incorporating all four dialects would increase the generalizability of the FFMQ-Bangla.

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Declarations

Ethical Approval The project obtained ethics clearance from the Monash University Human Research Ethics Committee (Project ID: 34710). Digital informed consent was recorded at the beginning of the online survey.

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