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ORIGINAL RESEARCH

# Assessing Emotion Regulation Difficulties Across Negative and Positive Emotions: Psychometric Properties and Clinical Applications of the Perth Emotion Regulation Competency Inventory in the Chinese Context

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**Background:** Abnormalities of regulating positive and negative emotion have been documented in patients with mental disorders. Valid and reliable psychological instruments for measuring emotion regulation across different valences are needed. The Perth Emotion Regulation Competency Inventory (PERCI) is a 32-item self-report measure recently developed to compressively assess emotion regulation ability across both positive and negative valences.

**Purpose:** This study aimed to validate the Chinese PERCI in a large non-clinical sample and examine the clinical utility in patients with major depressive disorder (MDD).

**Methods:** The Chinese PERCI was administered to 1090 Chinese participants (mean age = 20.64 years, 773 females). The factor structure, internal consistency, test-retest reliability, convergent validity, concurrent validity, and predictive validity were examined. Moreover, a MDD group (n = 50) and a matched healthy control group (n = 50) were recruited. Group comparisons and the linear discriminant analysis were conducted to assess the clinical relevance of the PERCI.

**Results:** Confirmatory factor analysis supported the intended eight-factor structure of the PERCI in the Chinese population. The PERCI showed high internal consistency, test-retest reliability, as well as good convergent and concurrent validity. The MDD group had significantly higher PERCI scores than the healthy control group. Linear discriminant function comprised of the eight factors successfully distinguish patients with MDD from their matched controls.

**Conclusion:** The Chinese version of the PERCI is a valid and reliable instrument to compressively measure emotion regulation across positive and negative valences in the general Chinese population and patients with depression.

**Plain Language Summary:** The Perth Emotion Regulation Competency Inventory was designed to comprehensively assess emotion regulation ability across both positive and negative valences. This study provided the first translation and psychometric evaluation of the PERCI in the Chinese context. The findings support that the Chinese version of the PERCI is a reliable and valid measurement for assessing emotion regulation across positive and negative valences in research and clinical practice.

**Keywords:** emotion regulation, reliability, validity, factor structure, depression

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## Introduction

Emotions are subjective responses to internal and external events across experiential, behavioral, and physiological channels of the emotion system.[1] Emotion regulation refers to the processes by which individuals modify the intensity, duration, or frequency of emotional experiences,[2,3] which plays an important role in adapting to the environment[4] and maintaining mental health.[5,6] Difficulties in emotion regulation have been observed in various mental disorders[7–10] and have been found as a key risk factor for the development and persistence of psychopathology,[11,12] including major depressive disorder,[13] anxiety disorder,[14] and autistic spectrum disorder.[15] Previous studies in Chinese population have found that emotion dysregulation is closely related with suicidal behaviors[16] and negative affect.[17] In addition, emotional intelligence has been suggested to have four components, including emotional expression, emotional regulation, intrinsic emotional satisfaction, and extrinsic emotional satisfaction.[18] Importantly, as the ultimate objective of emotional intelligence, the intrinsic and extrinsic emotional satisfaction has been found to be achieved through the process of emotional expression and emotional regulation.[18] Moreover, deficits in emotion regulation have been found to be closely related with worse well beings of both community population[19] and patients with mental disorders.[20] Therefore, it is crucial to develop reliable and suitable measures for emotion regulation ability.

Numerous tools have been developed to measure emotion regulation. For example, the Emotion Regulation Questionnaire (ERQ)[21] and the Cognitive Emotion Regulation Questionnaire (CERQ)[22] are widely used to assess individual differences in the habitual use of emotion regulation strategies. However, emotion regulation is a multifaceted construct, with emotion regulation strategies representing only one aspect of its broader framework. On the other hand, the Difficulties of Emotion Regulation Scale (DERS)[23] and the DERS-Positive[24] have been developed to evaluate emotion regulation difficulties, which provide an overall index of emotion regulation competency. Albeit the former taps into the regulation difficulties of negative emotions and the latter only assesses positive emotions. Furthermore, the DERS and the DERS-Positive have different number of items and factor structure. Therefore, it is difficult to combine the scores from both scales to provide an overall score of emotion regulation ability across negative and positive valences.[25] In addition, abnormal levels of both negative and positive emotions, including increased levels of negative emotions (eg, sadness and anxiety) and decreased levels of positive emotions (eg, anhedonia), are core symptoms of many mental disorders (such as mood disorder and psychotic disorders).[12,26,27]

In order to assess emotion regulation ability across both positive and negative valences in a single tool, Preece et al developed the Perth Emotion Regulation Competency Inventory (PERCI).[25] The PERCI is a multidimensional scale with 32 items, which assesses one's ability to alter emotions experientially, behaviorally, and cognitively across both positive and negative emotions.[25] It has four subscales in each valence: controlling experience, inhibiting behaviors, activating behaviors, and tolerating emotions. The ability to alter one's emotion in changing experiential feelings is assessed through a set of subscales named as Positive-Controlling experience (P-Sub; 4 items, eg, *I do not know what to do to create pleasant feelings in myself*) and Negative-Controlling experience (N-Sub; 4 items, eg, *when I am feeling bad, I have no control over the strength and duration of that feeling*). The ability to determine whether and when it is appropriate to implement emotion regulation through experiential channel in the first place, is measured by another set of subscales (Positive-Tolerating emotions, P-Tol; 4 items, eg, *when I am feeling good, I must try to eliminate those feelings*; Negative-Tolerating emotions, N-Tol; 4 items, eg, *when I am feeling bad, I must try to totally eliminate those feelings*). Behavioral responses are measured in the other two sets of subscales. They assess the ability to inhibit inappropriate response tendencies (Positive-Inhibiting behaviors, P-Inh; 4 items, eg, *when I am feeling good, my behavior becomes out of control*; Negative-Inhibiting behaviors, N-Inh; 4 items, eg, *when I am feeling bad, my behavior becomes out of control*) and activate desired behaviors when experiencing positive and negative emotions (Positive-Activating behaviors, P-Act; 4 items, eg, *when I am feeling good, I have trouble getting anything done*; and Negative-Activating behaviors, 4 items, N-Act; eg, *when I am feeling bad, I have trouble of getting anything done*). Moreover, the PERCI Positive-Emotion regulation composite and the PERCI Negative-Emotion regulation composite can be derived, which measures the ability to regulate positive and negative emotions separately. Finally, the total score of all items is a marker for the overall ability of emotion regulation ability.[25]

Preece et al[25] have demonstrated an eight-factor structure of the PERCI, which was consistent with contemporary emotion regulation theory.[3] Moreover, the PERCI has been found to have good reliability and validity in Australian, United States, Iranian, and Turkish samples.[25,28–31] As for the clinical application, McKay et al[32] utilized the PERCI in children with attention-deficit/hyperactivity disorder (ADHD) and found that the impairments in positive emotion regulation significantly predicted the social difficulties. To the best of our knowledge, the psychometric properties of the PERCI has not been examined in the Chinese context. Difficulties in emotion regulation have been found in patients with major depressive disorder (MDD)[8] and have been proposed to be a risk factor for the onset of depression.[33] Thus, we further examined the clinical utility of the Chinese PERCI in patients with MDD.

The purpose of the present study was to investigate the psychometric properties and clinical utility of the Chinese PERCI. First, the factor structure, internal and test-retest reliability, convergent and concurrent validity, as well as predictive validity of the PERCI were examined in a large non-clinical sample. Then, the clinical utility of the Chinese PERCI was examined in patients with MDD. Given that the eight-factor structure of the PERCI has been reported in previous studies across cultures,[25,28,30,31] We hypothesized that the Chinese version of the PERCI would retain the original eight-factor structure. Second, we hypothesized that the PERCI would have good psychometric properties. Finally, we expected that the PERCI scores would be able to distinguish patients with MDD from healthy controls successfully.

# Methods

## Participants

For the non-clinical sample, a total of 1717 participants were recruited through online and offline advertisement in Hangzhou, Beijing, and Qiqihar from June to October, 2022. Participants completed a battery of self-reported questionnaires through an online platform named Wenjuanxing (https://www.wjx.cn/). The online assessment took around 70 minutes. All participants received 25 RMB as compensation for their time. As all question items were preset as "mandatory" in the online platform, there was no missing value in our data. Ten pairs of lie or inattention detection items were incorporated in the set of questionnaires to detect non-valid response patterns.[34,35] An example pair is (a) I want to know others; and (b) I do not want to know others at all. Ten pairs of items could be found in Supplementary Table S1. The exclusion criteria for the non-clinical sample were as follows: (1) presence of current or past mental disorders, (2) having a family history of mental disorders, (3) having a history of neurological disorders or significant head injuries, (4) having substance abuse or alcohol dependence, and (5) providing conflicting responses for more than 3 lie/inattention-detection item pairs.[36,37] A total of 1090 participants ($M_{age}$ = 20.64 years, $SD_{age}$ = 2.96 years; $M_{edu}$ = 14.12 years, $SD_{edu}$ = 1.87 years, 317 males; see Table 1) were included for further analyses. Most participants identified themselves as Han Chinese (95.23%) and few participants (4.77%) are ethnic minorities. Ethnicity and other diversity issues were not further explored in current study. Furthermore, all participants were contacted through text to completed the PERCI again after a four-week interval to assess the test-retest reliability. A total of 340 responses were collected.

For the clinical utility, the required minimum number of participants was 42 for each group, with effect size of 0.15, a of 0.05, power of 0.95 calculated using G*Power.[38] A total of 50 patients with MDD were recruited from a Mental Health Center. They were diagnosed using the Diagnostic and Statistical Manual of Mental Disorder-IV (DSM-IV) Axis I disorders.[39] The exclusion criteria for the clinical sample were: (1) having a history of head trauma or neurological disorders, (2) having a history of substance or alcohol dependence, (3) having mental retardation, (4) having a history of transcranial magnetic stimulation or electroconvulsive therapy in past 12 weeks. The 17-item Hamilton Rating Scale (HAMD) was used by qualified psychiatrists to assess the depressive symptoms of patients. All patients were medicated with an average fluoxetine equivalent of 29.96 (± 15.89) mg/day. The mean illness duration was 4.18 (± 6.17) years. Moreover, 50 healthy controls were recruited from the local communities. The exclusion criteria for healthy controls were the same as those in the large non-clinical sample. The procedure of participants' recruitment is presented in Figure 1.

All participants provided informed consent. The study was approved by the Ethics Committee of the University (protocol number: 20221206) and was conducted in accordance with the Declaration of Helsinki.

**Table 1** Descriptive Statistics and Reliability of the Administered Measures

| | The large sample (n = 1090) | | | MDD (n = 50) | | HC (n = 50) | | $F/\chi^2$ | *p* |
|---|---|---|---|---|---|---|---|---|---|
| | *M (SD)* | *α* | *ICC* (n= *340)* | *M (SD)* | *α* | *M (SD)* | *α* | | |
| **Demographics** | | | | | | | | | |
| Age | 20.64 (2.96) | | | 32.96 (8.89) | | 30.28 (5.98) | | 1.77 | 0.080 |
| Gender (Male: Female) | 317:773 | | | 13:37 | | 16:34 | | 0.66 | 0.513 |
| Edu | 14.12 (1.87) | | | 12.98 (2.97) | | 15.32 (1.85) | | −4.73 | **<0.001***** |
| BDI | 7.27 (9.01) | | | 19.14 (10.83) | | 2.62 (4.20) | | 101.16 | **<0.001***** |
| **PERCI** | | | | | | | | | |
| Total | 105.86 (29.85) | 0.95 | 0.86 | 106.68 (32.86) | 0.94 | 80.26 (24.98) | 0.95 | 20.49 | **<0.001***** |
| N-Sub | 15.38 (5.23) | 0.85 | 0.81 | 19.4 (6.25) | 0.92 | 11.52 (4.43) | 0.78 | 52.93 | **< 0.001***** |
| N-Inh | 14.24 (5.40) | 0.84 | 0.80 | 17.04 (6.92) | 0.88 | 10.50 (4.65) | 0.87 | 30.76 | **< 0.001***** |
| N-Act | 17.57 (5.19) | 0.85 | 0.76 | 19.44 (6.68) | 0.94 | 12.74 (5.17) | 0.84 | 31.46 | **< 0.001***** |
| N-Tol | 15.73 (5.01) | 0.79 | 0.73 | 19.22 (5.48) | 0.77 | 13.36 (4.82) | 0.83 | 32.21 | **< 0.001***** |
| P-Sub | 12.58 (4.81) | 0.81 | 0.76 | 9.44 (5.70) | 0.84 | 9.74 (3.64) | 0.70 | 0.10 | 0.754 |
| P-Inh | 11.07 (4.78) | 0.80 | 0.76 | 7.14 (4.53) | 0.80 | 7.78 (3.06) | 0.70 | 0.69 | 0.410 |
| P-Act | 10.27 (4.63) | 0.84 | 0.73 | 7.24 (4.48) | 0.78 | 7.36 (2.94) | 0.83 | 0.03 | 0.874 |
| P-Tol | 9.02 (4.88) | 0.89 | 0.70 | 7.76 (5.28) | 0.85 | 7.26 (3.35) | 0.86 | 0.32 | 0.573 |
| N-Composite | 62. 91 (17.68) | 0.93 | 0.82 | 75.10 (23.27) | 0.96 | 48.12 (16.23) | 0.93 | 45.214 | **< 0.001***** |
| P-Composite | 42.95 (16.68) | 0.94 | 0.78 | 31.58 (18.12) | 0.94 | 32.14 (11.30) | 0.92 | 0.03 | 0.853 |
| **ERQ** | | | | | | | | | |
| Cognitive Reappraisal | 31.06 (5.46) | 0.85 | | 25.96 (6.99) | 0.88 | 60.66 (9.01) | 0.77 | 30.17 | **<0.001***** |
| Suppression | 14.60 (5.13) | 0.78 | | 16.74 (4.04) | 0.82 | 29.76 (4.74) | 0.69 | 11.16 | **0.001**** |
| **DASS** | | | | | | | | | |
| Total | 16.60 (14.63) | 0.96 | | 46.88 (14.94) | 0.89 | 29.26 (9.12) | 0.93 | 50.65 | **<0.001***** |
| Anxiety | 5.51 (4.89) | 0.88 | | 14.54 (4.63) | 0.88 | 9.72 (3.14) | 0.76 | 37.09 | **<0.001***** |
| Depression | 4.56 (5.11) | 0.91 | | 16.34 (7.10) | 0.60 | 8.62 (2.44) | 0.78 | 52.85 | **<0.001***** |
| Stress | 6.53 (5.39) | 0.90 | | 16.00 (4.77) | 0.90 | 10.92 (4.15) | 0.86 | 32.26 | **<0.001***** |
| **DERS** | | | | | | | | | |
| Total | 88.43 (23.03) | 0.94 | | 106.06 (20.69) | 0.93 | 90.98 (22.24) | 0.95 | 12.32 | **0.001**** |
| Non-Acceptance | 13.84 (5.58) | 0.89 | | 17.14 (5.38) | 0.91 | 12.08 (4.94) | 0.87 | 24.00 | **<0.001***** |
| Awareness | 14.91 (4.28) | 0.78 | | 18.36 (3.52) | 0.61 | 21.82 (4.18) | 0.76 | 20.08 | **<0.001***** |
| Strategies | 20.04 (7.15) | 0.89 | | 23.244 (5.90) | 0.82 | 17.64 (6.59) | 0.87 | 20.06 | **<0.001***** |
| Engagement | 15.27 (4.46) | 0.84 | | 15.50 (3.23) | 0.51 | 12.56 (4.01) | 0.77 | 16.28 | **<0.001***** |
| Impulsiveness | 13.64 (5.32) | 0.88 | | 17.46 (4.54) | 0.72 | 13.02 (4.65) | 0.85 | 23.34 | **<0.001***** |
| Clarity | 10.73 (3.49) | 0.75 | | 13.46 (2.61) | 0.22 | 13.86 (2.54) | 0.41 | 0.94 | 0.334 |

**Notes**: Significant results were in bold. *Indicates $p < 0.05$, **indicates $p < 0.01$, ***indicates $p < 0.001$.

**Abbreviations**: MDD, major depressive disorder; HC, healthy controls; Edu, years of education; BDI, Beck Depression Inventory; PERCI, Perth Emotion Regulation Competency; N-Sub, Negative-Controlling experience; N-Inh, Negative-Inhibiting behavior; N-Act, Negative-Activating behavior; N-Tol, Negative-Tolerating emotions; P-Sub, Positive-Controlling experience; P-Inh, Positive-Inhibiting behavior; P-Act, Positive-Activating behavior; P-Tol, Positive-Tolerating emotions; N-Composite, composite score of negative valence; P-Composite, composite score of positive valence; ERQ, Emotion Regulation Questionnaire; DASS, Depression Anxiety Stress Scale; DERS, Difficulty of Emotion Regulation Questionnaire; Non-Acceptance, difficulty accepting emotional responses; Awareness, lack of emotional awareness; Strategies, limited access to emotion regulation strategies; Engagement, difficulties engaging in goal-directed behavior when emotionally aroused; Impulsiveness, impulse control difficulties; Clarity, lack of emotional clarity.

# Measures

## The Chinese Version of the Perth Emotion Regulation Competency Inventory (PERCI)

The PERCI is a 32-item self-report measure designed to assess one's ability to regulate positive and negative emotions.[25] The PERCI has eight subscales (controlling emotions, inhibiting behaviors, activating behaviors, and tolerating emotions for both negative and positive emotions). All items are answered on a 7-point Likert scale (from 1 as for "strongly disagree" to 7 as for "strongly agree"), with higher scores indicating higher levels of difficulties in emotion regulation.

With permission to translate and validate the PERCI from the authors,[25] a bilingual expert in psychology and a postgraduate student majoring in psychology translated the English version of the PERCI into Chinese independently.

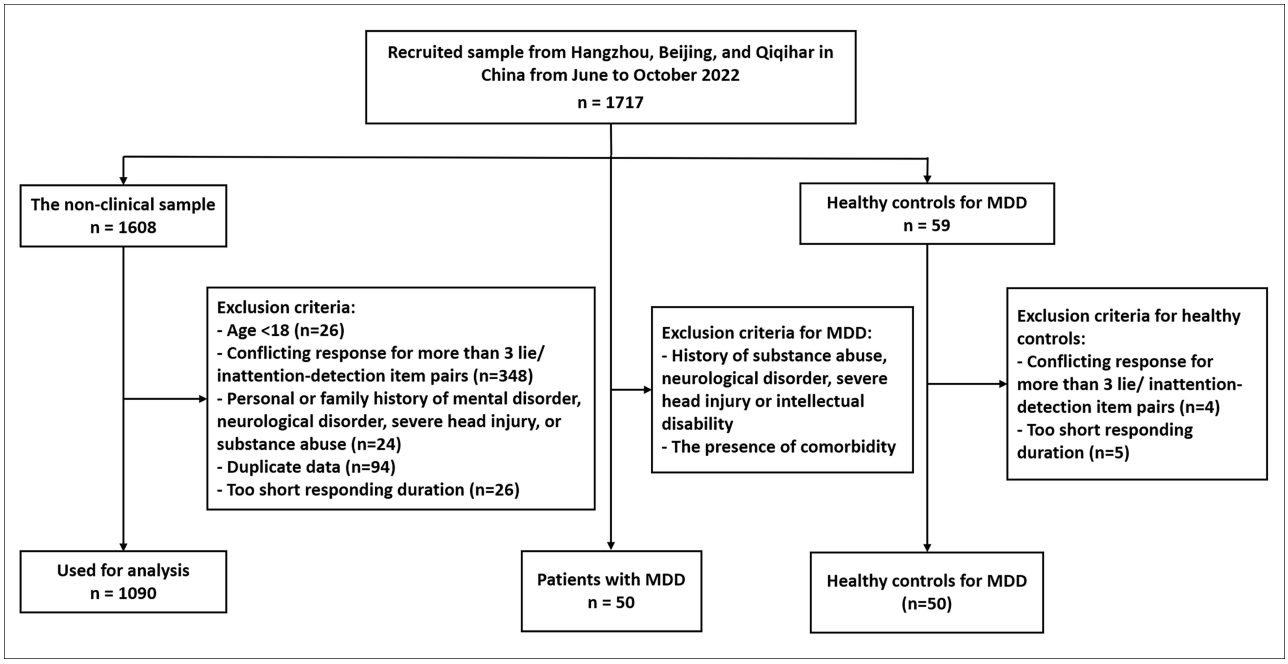


**Figure 1** Flow chart of participants recruitment.

After comparing the two draft versions, discrepancies were identified and reconciled through discussions and consensus. Then, another bilingual psychology expert who had no previous knowledge of the original version of the PERCI back-translated the revised Chinese version. Further modifications were made to achieve highest possible interchangeability between the original version and the Chinese version of the PERCI. The Chinese translation of the PERCI can be found in the Supplementary Table S2.

## The Beck Depression Inventory (BDI)

The BDI is a 21-item self-reported questionnaire for measuring the severity of depressive symptoms.[40,41] Each item is rated on a 4-point Likert scale ranging from 0 (symptom absent) to 3 (severe symptom), with higher scores indicating higher levels of depression. The Chinese version of the BDI has been validated to have good psychometric properties.[41] The Cronbach's alpha coefficient for the BDI was 0.94 in the large non-clinical sample.

## The Emotion Regulation Questionnaire (ERQ)

The ERQ is a 10-item self-report questionnaire to assess the individual difference in two emotion regulation strategies (Cognitive Reappraisal and Expressive Suppression).[21,42] Each item is rated on a 7-point Likert scale ranging from 1 (completely disagree) to 7 (completely agree), with higher scores indicating higher frequency of using the certain regulation strategy. The Chinese version of the ERQ has showed good psychometric properties.[42] The Cronbach's alpha for the Cognitive Reappraisal subscale and the Expressive Suppression subscale were 0.86 and 0.79 in the large non-clinical sample, respectively.

## The Depression Anxiety and Stress Scale (DASS-21)

The DASS-21 is a 21-item self-reported measure of depression, anxiety, and stress.[36,43] Each item is rated on a 4-point Likert scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time), with higher scores indicating greater severity of the symptoms. The Chinese version of the DASS has been validated to have good reliability and validity.[36] The Cronbach's alphas for the DASS-21 subscales and the total score in our large non-clinical sample were 0.84 (for the Anxiety subscale), 0.88 (for the Depression subscale), 0.87 (for the Stress subscale), and 0.95 (for the total score).

### The Difficulties in Emotion Regulation Scale (DERS)

The DERS is a 36-item self-report scale assessing difficulties in emotion regulation.[23,44] The DERS has 6 subscales, including difficulty accepting emotional responses, lack of emotional awareness, limited access to emotion regulation strategies, difficulties engaging in goal-directed behaviors when emotionally aroused, impulse control difficulties, and lack of emotional clarity. Items are rated on a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always), with higher scores indicating higher levels of difficulties in emotion regulation. The Chinese version of the DERS has been shown to have consistent factor structure, as well as adequate reliability and validity.[44] The Cronbach's alphas for the DERS subscales and the total score in our large non-clinical sample were 0.89, 0.79, 0.89, 0.84, 0.87, 0.74, and 0.93, respectively.

## Data Analyses

Data analyses were conducted using SPSS version 22 and AMOS 21.0 (IBM, released 2013; IBM SPSS Statistics for Windows, Version 22.0). Eight factor structure of the PERCI (one-factor model, two-factor model, four-factor model, bifactor model, and four eight-factor models with a first-order latent variable, two second-order variables, and a third-order latent variable; see Supplementary Figure S1) were assessed via confirmatory factor analyses (CFA, maximum likelihood estimation based on a Pearson covariance matrix) in AMOS 26. The goodness-of-fit indices of the CFA models included the comparative fit index (CFI), Tucker Lewis index (TLI), Akaike information criterion (AIC), root mean square error of approximation (RMSEA), and standardized root mean residual (SRMR). A smaller AIC value indicated a better fit of the model.[45] When CFI $\geq$ 0.90,[46] TLI $\geq$ 0.90,[47] RMSEA $\geq$ 0.08[48] and SRMR $\geq$ 0.08,[47] the model would be considered as a good fit to the data.[46,47,49] To improve the robustness of the findings, all models were tested using the package lavaan version 0.6–18[50] in R to for confirmatory factor analysis with robust maximum likelihood estimation (MLR).

Internal consistency reliability of the PERCI subscales, composite, as well as total scale was evaluated using the Cronbach's α coefficients (with accepted value $\geq$ 0.70, good $\geq$ 0.80, excellent $\geq$ 0.90). Test-retest reliability was assessed with the intraclass correlation coefficients (ICC, ICC $\geq$ 0.50 is considered moderate, $\geq$0.75 as good, and $\geq$0.90 as excellent).[51] Convergent validity was assessed by conducting correlations between the PERCI scores and the ERQ as well as the DERS scores. To evaluate concurrent validity, correlations between the PERCI scores and the DASS subscales scores were calculated. In order to investigate whether the PERCI scores could predict depressive levels in the non-clinical sample, predictive validity of the PERCI was examined by conducting a stepwise multiple regression analysis, with the BDI scores as the dependent variable and the PERCI scores as well as the demographic factors as the predictor variables. Incremental validity was checked through another stepwise multiple regression analysis testing to what extent the PERCI adding predictability of BDI to the ERQ (set as step 1) and DERS (set as step 2).[52]

To explore the clinical utility of the PERCI, variance analysis was applied to compare the PERCI total score between patients with MDD and healthy controls. Multivariate analyses of variance (MANOVA) were used to compare the scores of PERCI subscales and composites between the two groups. A Bonferroni correction (0.05/ 8= 0.00625) was applied for multiple testing. As healthy controls have significantly longer years of education than that of patients with MDD, multivariate analyses of covariance were conducted with gender, age, and years of education as covariances. Finally, a linear discriminant analysis was conducted to examine the extent to which the PERCI could be used to differentiate the two groups.

# Results

## Factor Structure

As shown in Table 2, the eight-factor model with a first-order latent variable fitted to the data best. All items loaded above 0.50 on each factor and all the eight factors were significantly and positively correlated in the first-order eight-factor model (see Figure 2). The one-factor model, two-factor model, and four-factor model worked worse than the eight-factor models, further supporting the necessity of separating factors based on different channels and different valences of emotion regulation. Results of CFA using MLR also found the eight-factor structure the best fitting model (see Supplementary Table S3).

**Table 2** Goodness-of-Fit Index Values from Confirmatory Factor Analyses of the PERCI

| Model | $\chi^2$ / df | RMSEA | SRMR | CFI | TLI | AIC |
|---|---|---|---|---|---|---|
| One-factor | 20.078 | 0.132 | 0.134 | 0.589 | 0.560 | 9508.257 |
| Two-factor | 9.590 | 0.089 | 0.083 | 0.815 | 0.802 | 4634.028 |
| Bifactor | 8.679 | 0.084 | 0.130 | 0.737 | 0.823 | 4005.260 |
| Four-Factor | 17.501 | 0.123 | 0.149 | 0.649 | 0.620 | 8219.306 |
| **First-order eight-factor** | **4.865** | **0.060** | **0.054** | **0.922** | **0.911** | **2305.176** |
| Second-order eight-factor a | 5.686 | 0.066 | 0.079 | 0.901 | 0.892 | 2733.012 |
| Second-order eight-factor b | 8.978 | 0.086 | 0.135 | 0.831 | 0.816 | 4302.023 |
| Third-order eight-factor | 5.686 | 0.066 | 0.079 | 0.901 | 0.892 | 2733.012 |

**Note**: The best fitting model was in bold.
**Abbreviations**: PERCI, Perth Emotion Regulation Competency Inventory; RMSEA, root mean square error of approximation; SRMR, standardized root mean residual; CFI, comparative fit index; TLI, Tucker Lewis index; AIC, Akaike information criterion.

## Reliability

The Cronbach's alpha coefficient for the PERCI total score was 0.95 in the non-clinical sample (see Table 1), indicating excellent internal consistency reliability. The Cronbach's alpha coefficients of the PERCI subscales and composite scores ranged from 0.79 to 0.95, demonstrating good to excellent internal consistency reliability. For patients with MDD and healthy controls, the Cronbach's alpha coefficients were both above 0.70, showing good internal consistency in general (see Table 1). In terms of test-retest reliability, the ICC for the PERCI subscales, composites, and total scale scores ranged from 0.70 to 0.86, indicating good to excellent test-retest reliability.

## Validity

### Convergent and Concurrent Validity

Pearson correlation coefficients among the PERCI, the DERS, ERQ, and DASS are presented in Figure 3a. In general, higher PERCI scores were significantly correlated with more difficulties in emotion regulations (as measured by the DERS), lower frequency of using the adaptive emotion regulation strategy, and higher frequency of using the maladaptive strategy (as measured by the ERQ), suggesting that the PERCI had good convergent validity. In addition, the PERCI subscales and composite scores, as well as total score were significantly and positively correlated with the DASS subscales scores, indicating good concurrent validity of the PERCI.

### Predictive and Incremental Validity

For predictive validity, results of stepwise regression analyses are presented in Table 3. After controlling for gender, age, and years of education ($R^2$ = 0.028, adjusted $R^2$ = 0.026, $F$ (3, 985) = 10.572, $p < 0.001$; function coefficient for three factors were −1.802, 0.467, −0.434, respectively, for the constant was 6.794), the BDI scores could be significantly predicted by the four subscales of the PERCI (Negative-Controlling experience, Negative-Inhibiting behaviors, Positive-Controlling experience, and Positive-Tolerating emotions, $R^2$ = 0.313, adjusted $R^2$ = 0.309, $F$ (7, 981) = 70.509, $p < 0.001$; function coefficient for the subscales were 0.442, 0.241, 0.288, and 0.219, respectively, for the constant was −10.852). For the incremental validity, the regression analysis showed that the PERCI significantly increase the predictability of the BDI ($R^2$ = 0.405, adjusted $R^2$ = 0.397, $R^2$ changed = 0.028, $p < 0.05$; Supplementary Table S4).

## Clinical Utility

As shown in Table 1, patients with MDD had significantly higher PERCI total scores than healthy controls ($F_{(1, 98)} = 20.49$, $p < 0.001$, $\eta^2 = 0.17$). As for the PERCI subscales scores, results from MANOVA showed significant differences between patients with MDD and healthy controls (see Table 1). Follow-up ANOVAs showed significant between-group differences in the negative subscales and negative composite scores of the PERCI, while non-significant differences were found in the positive subscales and positive composite scores (see Figure 3b). The results from MANCOVA showed consistent results with

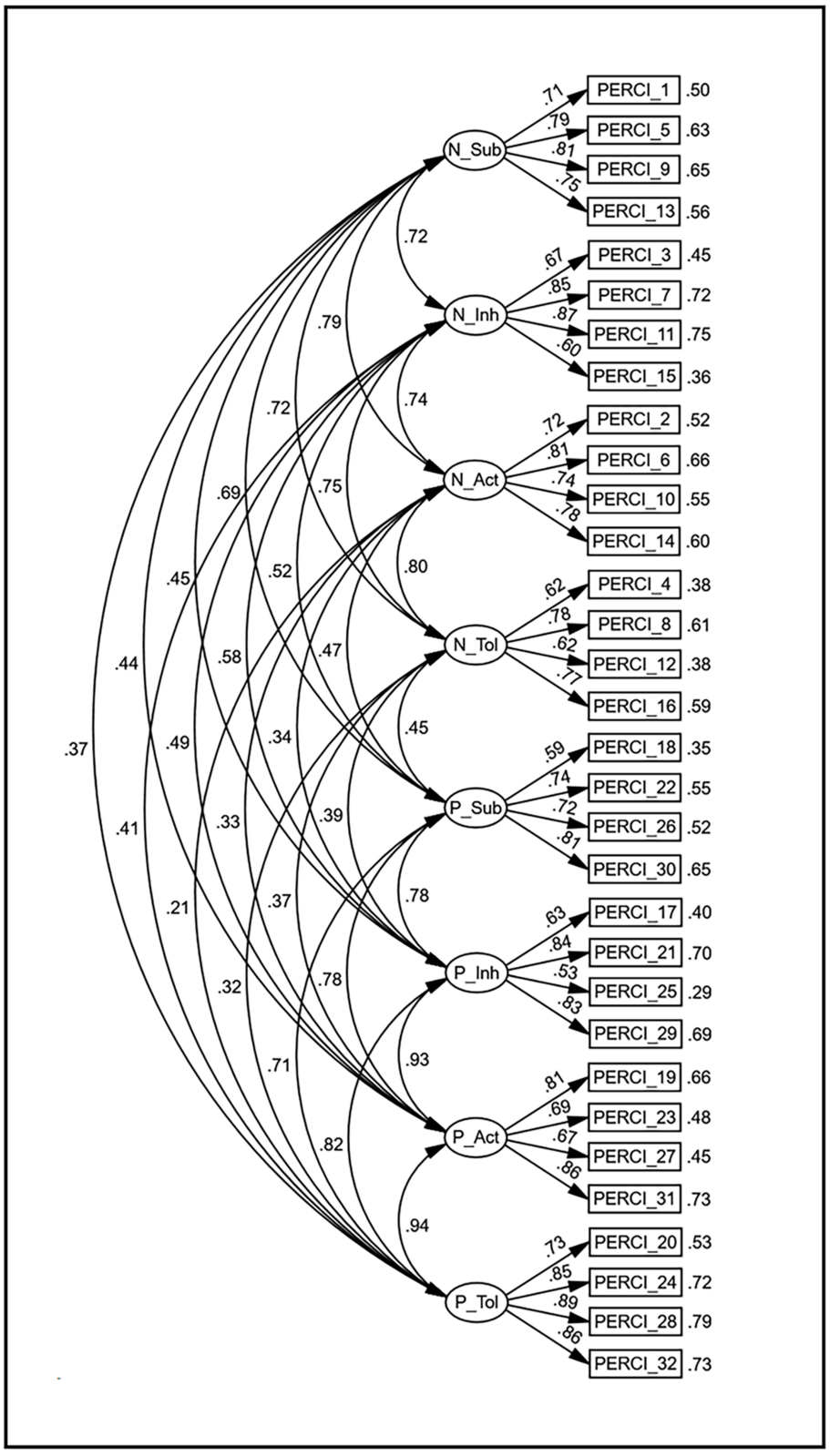


**Figure 2** Graphical representations of the eight-factor model with factor loadings.

**Abbreviations**: PERCI, Perth Emotion Regulation Competency Inventory; N-Sub, Negative-Controlling experience; N-Inh, Negative-Inhibiting behavior; N-Act, Negative-Activating behavior; N-Tol, Negative-Tolerating emotions; P-Sub, Positive-Controlling experience; P-Inh, Positive-Inhibiting behavior; P-Act, Positive-Activating behavior; P-Tol, Positive-Tolerating emotions.

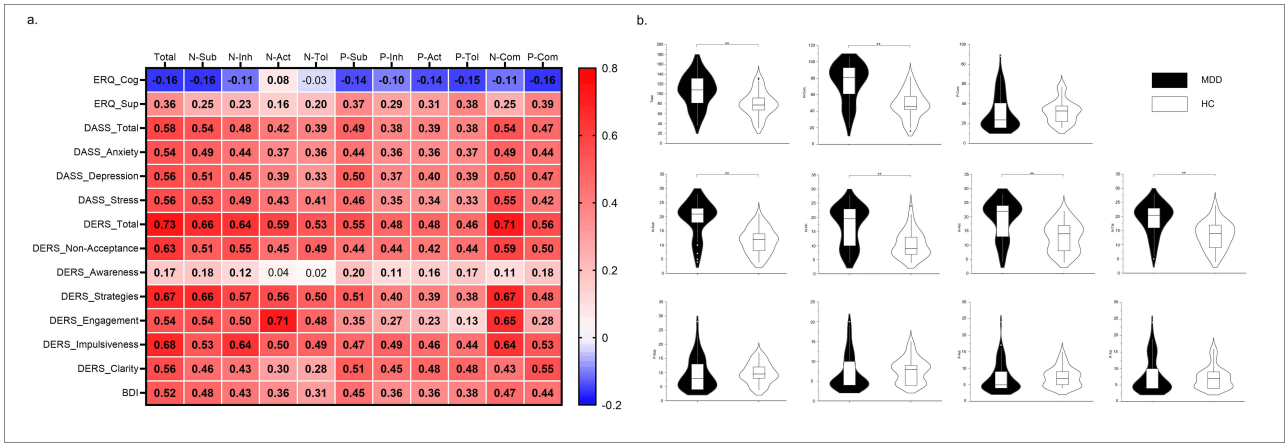


**Figure 3** (**a**) Correlation coefficient matrix diagram of the PERCI, DERS, ERQ, DASS, and BDI. (**b**) Violin plots of the PERCI subscales, composite, and total scale scores in patients with MDD and healthy controls.

**Notes**: Significant correlations ($p < 0.05$) were represented in bold.

**Abbreviations**: Total, total score of the Perth Emotion Regulation Competency Inventory; N-Com, composite score of negative emotion regulation subscales; P-Com, composite score of positive emotion regulation subscales; N-Sub, Negative-Controlling experience; N-Inh, Negative-Inhibiting behavior; N-Act, Negative-Activating behavior; N-Tol, Negative-Tolerating emotions; P-Sub, Positive-Controlling experience; P-Inh, Positive-Inhibiting behavior; P-Act, Positive-Activating behavior; P-Tol, Positive-Tolerating emotions; ERQ_Cog, Cognitive reappraisal in the Emotion Regulation Questionnaire; ERQ_Sup, Suppression in the Emotion Regulation Questionnaire; DASS_Total, total score of the Depression Anxiety Stress Scale; DERS_Total, total score of the Difficulties in Emotion Regulation Scale; Non-Acceptance, difficulty accepting emotional responses; Awareness, lack of emotional awareness; Strategies, limited access to emotion regulation strategies; Engagement, difficulties engaging in goal-directed behavior when emotionally aroused; Impulsiveness, impulse control difficulties; Clarity, lack of emotional clarity; BDI, Beck Depression Inventory; MDD, patients with major depressive disorder; HC, healthy controls. **$p < 0.01$.

the MANOVA (see Supplementary Table S5). Furthermore, the scores of the HAMD were positively and significantly correlated with the total, subscale, and composite scores of the PERCI (see Supplementary Table S6).

Finally, results of the linear discriminant analysis showed that the discriminant function (discriminant score = 1.012 × Negative-Controlling experience +0.228 × Negative-Inhibiting behavior – 0.182 × Negative-Activating behavior +0.057 × Negative-Tolerating emotions – 0.510 × Positive-Controlling experience – 0.459 × Positive-Inhibiting behavior – 0.122 × Positive-Activating behavior +0.555 × Positive-Tolerating emotions) significantly distinguished patients with MDD from healthy controls ($\lambda = 0.56$, $\chi^2(8) = 54.77$, $p < 0.001$). The discriminant function was able to correctly classify 82.00% of the originally grouped participants (74.00% for patients with MDD, 90.00% for healthy controls).

**Table 3** Stepwise Multiple Regression of the BDI Score on Demographic Factors and Each Subscale of the PERCI

| Predictors added | $R^2$ | Adjusted $R^2$ | $\Delta F$ | B | SE B | β | t | p | Collinearity statistics | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Tolerance | VIF |
| Gender | 0.028 | 0.026 | **10.572*** ** | −1.802 | 0.593 | −0.091 | −3.036 | **< 0.002**** | 0.991 | 1.009 |
| Age | | | | 0.467 | 0.104 | 0.151 | 4.476 | **< 0.000***** | 0.790 | 1.266 |
| Edu | | | | −0.434 | 0.162 | −0.090 | −2.680 | **< 0.007**** | 0.785 | 1.273 |
| **PERCI** | | | | | | | | | | |
| N-Sub | 0.313 | 0.309 | **70.509***** | 0.442 | 0.061 | 0.257 | 7.206 | **< 0.001***** | 0.498 | 2.007 |
| N-Inh | | | | 0.241 | 0.055 | 0.145 | 4.430 | **< 0.001***** | 0.590 | 1.694 |
| P-Sub | | | | 0.288 | 0.070 | 0.154 | 4.128 | **< 0.001***** | 0.454 | 2.202 |
| P-Tol | | | | 0.219 | 0.062 | 0.119 | 3.566 | **< 0.001***** | 0.567 | 1.764 |

**Notes**: Significant results were in bold. **indicates $p < 0.01$, ***indicates $p < 0.001$.

**Abbreviations**: Edu, years of education; PERCI, Perth Emotion Regulation Competency Inventory; N-Sub, Negative-Controlling experience; N-Inh, Negative-Inhibiting behavior; P-Sub, Positive-Controlling experience; P-Tol, Positive-Tolerating emotions.

## Discussion

In the present study, we examined the psychometric properties of the Chinese version of the PERCI in a large non-clinical sample and explored the clinical utility of the PERCI in patients with MDD. The Chinese version of the PERCI appeared to show a reliable eight-factor structure. The PERCI demonstrated good to excellent internal and test-retest reliability, as well as high convergent and concurrent validity. Moreover, the Chinese version of the PERCI significantly distinguished patients with MDD from healthy controls.

The results of the CFA strongly supported the intended eight-factor structure, which is consistent with the original PERCI study (in Australian adults).[25] Furthermore, previous studies also reported that the PERCI had a robust eight-factor structure in individuals from different cultural background, such as American adults, Iranian adults, and Iranian adolescents.[28,31] These findings provide robust evidence for the multidimensional emotion construct of emotion regulation ability across Eastern and Western cultures. Moreover, the eight-factor models have better fit to the data than the simpler models, highlighting the significance of distinguishing different valence as well as different channels of emotion regulation.[21] Positive emotions play a crucial role in various settings, including education[53] and work.[54] Moreover, emotion regulation has been found to be influenced by cultural contexts.[55] Asian values, such as interdependence and harmony in relationships, may contribute to emotional suppression.[56,57] Assessing positive emotions through the four channels suggested by the extended process model will enhance our understanding of positive emotion regulation.

The reliability of the Chinese PERCI was comparable to those in the original version,[25] which evidenced a successful cross-cultural adaptation of the PERCI. We further extended the test-retest reliability of the PERCI over a 4-week interval, with ICCs generally higher than those reported by Mazidi et al.[31] Significant correlations between the PERCI and the DERS, the ERQ, as well as the DASS and the BDI suggest a robust convergent and concurrent validity. Interestingly, our findings further showed that the depressive symptoms in general population was significantly predicted by both negative and positive subscales of the PERCI, highlighting the importance to distinguish negative and positive valences of emotion regulation ability. Accumulating evidence have documented a robust association between difficulties in emotion regulation and worse well-being in general population.[58–61] Furthermore, dysregulation of positive emotion has been found in a wide range of mental disorders.[27,62] Therefore, future research utilizing the PERCI might provide valuable insights into our understanding of regulating both positive and negative emotions.

As expected, we observed that patients with MDD had significantly higher total scores of the PERCI than healthy controls, indicating defected emotion regulation ability in patients with depression. Notably, a large body of literature has pointed out that dysregulation of emotion being a hallmark of depression.[33,63,64] Further, we found worse emotion regulation ability for negative emotion in patients with MDD, which is consistent with previous studies.[33,63,65] Depression severity was found to be positively correlated with the PERCI.[66] However, patients with MDD were not significantly different in emotion regulation ability for positive emotion as compared with healthy controls. Medication might be a confounding factor which contributed to the non-significant results. In our study, patients with MDD were medicated using fluoxetine or other antidepressant medicine. Medication-naïve patients with MDD were found to have impairments in regulating both positive and negative emotions than healthy controls.[67] A pharmacological study in healthy volunteers has demonstrated that even a single dose of fluoxetine consumption would influence emotional processing.[68] In addition, patients with MDD were found to exhibit increased hedonic capacity after 8 weeks of treatment with antidepressant medications.[69] Therefore, different stages of MDD patients (such as medication-naïve patients, medicated patients, and remitted patients) should be recruited in the future to explore the clinical utility of the PERCI.

This study has several limitations. First, the non-clinical sample and healthy controls were not screened using clinical interviews, such as Mini-International Neuropsychiatric Interview.[70] Second, most of the data used in this study was cross-sectional and obtained through convenience sampling. Although we collected follow-up data for the PERCI with a 4-week interval, additional longitudinal data would be necessary to assess the invariance of emotion regulation over time. Third, the PERCI was designed to be used in a wide range of populations. Our study only recruited adults and patients with MDD, which limited the generalization of the findings. Future studies are encouraged to apply the PERCI in samples across different age (ie, adolescents) and with other mental disorders. Fourthly, the PERCI is a self-report assessment and all measures used to validate convergent validity were also based on self-report. Future effort is needed to

combine the PERCI with behavioral paradigms for emotion regulation to further validate the scale. Next, the gender composition of our sample was uneven and the gender invariance of the PERCI remained unknown in current sample. However, as previous study found gender invariance in American and Iranian samples,[31] we would speculate that the PERCI would also exhibit gender invariance in a Chinese context. Future studies should recruit samples with balanced gender ratios to explore the question of gender invariance. Lastly, as suggested by Preece et al, existing measures on emotion regulation could be broadly classified into two categories, including process (or strategy used, such as the ERQ) and competence (or ability/difficulties to regulate emotions, such as the DERS). The PERCI only measures emotion regulation difficulties. Future assessment tools are recommended to provide a more comprehensive evaluation of emotion regulation.

## Conclusion

In conclusion, our findings suggest that the Chinese version of the PERCI is a reliable and valid instruct to measure emotion regulation ability across positive and negative valences. Furthermore, the Chinese PERCI could successfully differentiate patients with MDD from their matched controls. Therefore, application of the PERCI in the future might help advance our understanding of emotion regulation among the Chinese population and might contribute to develop novel therapies for depression.

## Data Sharing Statement

Data for this study are available upon reasonable request by contacting the corresponding author.

## Ethical Approval

The study was approved by the Ethics Committee of the school of Basic Medical Sciences, Hangzhou Normal University, China. The study complies with the Declaration of Helsinki.

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## Disclosure

The authors report there are no competing interests to declare in this work.

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