

Factor Structure of the Ruminative Response Scale and Measurement Invariance across Gender and Age among Chinese Adolescents

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Abstract

Methods: Participants included 1103 adolescents from Hunan Province and Hainan Province in China. A confirmatory factor analysis (CFA) was conducted to determine the structure of the RRS on a large scale. Multiple CFAs were utilized to test the measurement invariance of the three subscales included in the RRS, across gender and age. **Results:** The RRS exhibited strong internal consistency (overall Cronbach's alpha coefficient = 0.927) and internal reliability (0.362 - 0.864). The CFA showed a valid three-factor model. Measurement invariance of the model across gender and age was fully supported. **Conclusions:** Total RRS and subscales have accepted validity and reliability. Three-factor model of the RRS across gender and age was established. Measurement equivalence of the RRS across gender and age was established among Chinese adolescents. These findings suggest that the use of the RRS in comparing samples across gender and age is valid.

Keywords

Ruminative Response Scale, Factor Structure, Measurement Invariance, Gender and Age, Chinese Adolescents

1. Introduction

The Ruminative Response Scale (RRS) is frequently used self-report measure of depressive rumination in both research and clinical practice to assess the severity of depressive rumination. The current study evaluated the best-fit factor structure model of the Chinese version of the RRS among Chinese adolescents and evaluated the measurement invariance of the RRS across gender and age.

Adolescence is a special period in depression researches. With the increasing incidence of depression from childhood, adolescence is the main transitional period from childhood to adulthood. Therefore, the study of adolescent depression is of great significance. Previous researches have shown that the first episode of depression in individuals usually occurs between the ages of 14 and 19, and the prevalence of lifelong depression is as high as 25% at the end of adolescence (Kessler et al., 2001).

According to the cognitive model of depression, depression is caused by negative cognitive diagrams, so patients tend to choose negative information consistent with their own negative schema (Abramson et al., 1989). Rumination is a sensitive factor in the pathogenesis of depression and plays an important role in the generation and maintenance of depression (Thomsen et al., 2011). Research has showed the development of depression was associated with the rumination which is a risk factor for adolescence (Kelsey et al., 2017; Thomsen et al., 2013; McMurrich & Johnson, 2008). Further researches even showed that rumination wasn't only correlated with the symptoms of depression, but also could predict the onset of depressive disorders at each subsequent assessment, even over the subsequent year (Broderick & Korteland, 2004; Wilkinson et al., 2013).

According to the response styles theory (Nolen-Hoeksema et al., 1992), the gender difference of depression is discussed from the point of view of the cognitive strategy of the negative emotion, and the response styles were proposed: the brooding, the distraction and the problem solving. The brooding is the negative reaction style, and the distraction and the problem solving are the positive response styles (Dickson et al., 2017). As compared to boys, girls tend to be more likely to apply to the negative reaction style, so they are more likely to be depressed (Nolen-Hoeksema, 1987, 1991). Gender was investigated as a moderator which moderated the relation among brooding, reflection and depression symptoms (LeMoult et al., 2019). Related researches found that female adolescents reported more engagement in brooding rumination than male adolescent (Jos & Weir, 2013; Hamlat et al., 2015). Furthermore, the rumination was related to more concurrent and prospective depressive symptoms in girls, but reflection predicted less concurrent and prospective depressive symptoms in girls (Bastin et al., 2018, Paredes & Zumalde, 2015). Compared with males, related researches indicated that girls with more generalized autobiographical memories in combination with higher levels of rumination were most vulnerable to experiencing increases in depressive symptoms following stressful life events (Connolly et al., 2015). On the other hand, some researches found no differences were observed in gender on depression or rumination (Broderick & Korteland, 2004). Performance factorial invariance across ages is necessary to determine gender differences on the ruminative response scale (RRS).

Adolescence is a special period, with the significantly physical and psychological changes. At the same time, due to the non-synchronization of the physiological maturity and the mental maturity, the young people can be easily ab-

sorbed into the brooding, the depression, and so on. The total scores and subscales of the RRS may change with age as adolescents develop. Some longitudinal studies indicated that there was no statistically significant difference between two time points (Schoofs et al., 2010). While many studies have utilized the related scales to assess the effect of intervention and treatment (Wilkinson & Goodyer, 2008, Campbell et al., 2012), and therefore the time equivalence of the RRS has significance and value.

Two main versions of the RRS have been proposed, which differ in terms of item composition. The first report of RRS was put forward by Nolen-Hoeksema and Morrow (Nolen-Hoeksema, 1991) selected a priori 22 items for the RRS. In subsequent studies, Butler and Nolen-Hoeksema (Butler & Nolen-Hoeksema, 1994) used a two-factor version with 10 items. So more researches discussed the reliability and validity of the two factors of RRS (Hasegawa, 2013; Lei et al., 2017; Lucena-Santos et al., 2018), but less researches focused on the reliability and validity of the three factors. The RRS has emerged as the most frequently used self-report measure of depressive rumination in both researches and clinical practice for its wide target population and stable reliability and validity in Japanese, Dutch and Korean (Topper et al., 2014; Shin, Cho, & Kim, 2015). Researches about university students of Chinese had shown that the CFA about the two factors of RRS exceptive of depression fit the model and the measurement equivalence of the RRS-10 was acceptable across gender. Otherwise some related research also performed three factors of RRS to evaluate the depression, the rumination and the reflection (Stringars & Goodman, 2013; Treynor et al., 2003). So it is necessary to assess the three factor model of RRS.

The main aims of the research were to examine the factor structure of the 22-item RRS in Chinese adolescents, and to test the measurement invariance of the 22-item RRS across gender and age. The effective use of any scale is dependent on the measurement indices of the scale, and as such, the equivalence test is critical. True inter-group differences cannot be determined when there is measurement invariance (Stringars & Goodman, 2013).

2. Material and Methods

2.1. Participants

A total sample of 1134 students completed the RRS questionnaire. Age of participants ranged from 13 to 18 years ($M = 16.02$; $SD = 0.849$). Students from both urban and rural areas accounted for 41.8% and 58.2% respectively. Due to the small sample size of 13 year-olds ($n = 8$) and 18 year-olds ($n = 15$), these two ages were excluded from the analysis of age equivalence. Cases with missing data on gender, age, or RRS items were excluded. The final sample was comprised of 1102 adolescents (535 males and 567 females).

2.2. Procedure

The research was approved by the Ethics Committee of the Second Xiangya

Hospital, Central South University and Hainan Medical University. Participation was voluntary and signed parental informed consent was necessary to participate. All questionnaires were administered in the classroom, in the form of pen and paper. The questionnaire took approximately 40 minutes to complete. The questionnaire was administered at different times to at least four subjects at each session. The teacher of the class was present to ensure that the students cooperated.

2.3. Instruments

The Ruminative Response Scale (RRS) is a self-report questionnaire, which includes 22 items describing responses to depressed mood which distributed across three subscales: depression, brooding and reflection (Treyner et al., 2003). Responses can be acting or thinking about the depressive symptoms and thinking about possible causes and consequences of the sad/depressed mood. Each item are rated on a 4-point Likert scale ranging from 1 (never) to 4 (always). The total score ranges from 22 to 88, with higher scores indicating higher degrees of ruminative symptoms. The Brooding of the RRS assesses a maladaptive aspect of rumination, whereas the Reflection assesses an adaptive or relatively less maladaptive aspect of rumination,

The Chinese version RRS was developed through forward and back translation by separate bilingual translators. No questionnaire item was removed or altered significantly during translation.

2.4. Data Analyses

Epidata was used for data entry. SPSS and AMOS were used for data analysis. Due to the equilibrium of age distribution, normal tests were performed on every item. Descriptive analyses were performed in SPSS, V23.

A confirmatory factor analysis (CFA) was performed to assess the relationship between the three subscales. Model fit was assessed with various fit indices, including a robust χ^2 with estimated degrees of freedom (df), a comparative fit index (CFI), and a root mean squared error of approximation (RMSEA).

The reliability of the RRS was estimated with Cronbach's alpha, and a correlation analysis on the scores total and the three subscales. On the basis of Cronbach's alpha > 0.5, further analyses of construct reliability (CR) and average variance extracted (AVE) were performed.

After identification of the best fitting RRS model and considerable reliability, measurement invariance tests were conducted across gender and age for the effectiveness of inter-group comparisons. Five aspects of invariance were considered. Model 1: configural invariance tested the structure of latent variables across groups; Model 2: factor loading invariance based on Model 1 was constrained to be equal across gender; Model 3: scalar invariance based on the metric invariance results with variable intercepts constrained to equality; Model 4: factor covariance invariance was tested which verified equality of the covariance

between groups; and Model 5: a test of strong equivalence was performed, that is, residual error invariance with error variance was set as equal. The CFI and the Tucker Lewis Index (TLI) were used to evaluate invariance across consecutive models; CFI and TLI were more than 0.9, measurement invariance was accepted; a $\Delta\text{CFI} \leq 0.01$ with a $\Delta\text{TLI} \leq 0.01$ was considered evidence of invariance, as suggested by Cheung and Rensvold (Cheung & Rensvold, 2002).

3. Results

3.1. Normal Distribution Test

From the analysis results of the **Table 1**, it can be seen that the mean distribution of each item in the measurement variable is more balanced. The absolute value of skew coefficient of each item is 1.290, which is far less than the standard value of 3, and the absolute value of kurtosis coefficient is 1.147, which is much smaller than the standard value of 8 (Kline, 2005). It means that the data of each item approximately conform to the normal distribution. The maximum likelihood method (ML) can be used to model the CFA and the structural equation.

3.2. CFA

The three factors accounted accumulatively for 58.28% of the total variance. Item loadings are reported in **Figure 1**. The standardized factor loadings of the three-facet model are presented in **Figure 1**. The factor loadings of all items were greater than 0.4, except RRQ12 (Write down what you are thinking and analyze it.) of depression, item 13 (Think about a recent situation, wishing it had gone better) of brooding and item 14 (Think “I won’t be able to concentrate if I keep feeling this way.”) of the brooding subscale (0.36). Therefore, all items of three-factor model for the Chinese version RRS didn’t meet the criterion (Cheung & Rensvold, 2002). But after effect modification by cut-off the low factor loading item, the CFA revealed an moderate to good fit according to the CFI, GFI, TLI and RMSEA (0.916, 0.906, 0.872 and 0.062, respectively) (**Table 2**).

3.3. Reliability and Validity

The Cronbach’s alpha of the total score and each subscale were greater than 0.5 and inter-subscale correlations of the total score and each subscale ranged from 0.362 to 0.864 (**Table 3**). To further verify the reliability of the RRS, we performed Construct Reliability (CR) and Average Variance Extracted (AVE), the results are shown in **Table 3**. The CRs of all subscales were greater than 0.6, and all AVEs were relatively lower which indicates that the latent variable has good Better combination reliability but limited convergence validity (Fornell & Larcker, 1981; Tsaousis & Kazi, 2013).

3.4. Factorial Invariance across Gender

Multiple-group analysis was performed to examine the cross-gender structural

equivalence of the RRS. In addition, the model served as a baseline for the proceeding analysis. The following fit indices were obtained: TLI = 0.873, CFI = 0.917, GFI = 0.932, RMSEA (90% CI) = 0.043 (0.038, 0.049) respectively. Each fit index (see **Table 4**) met the requirements for configural invariance (**Table 4**).

Based on the configural invariance, equivalent factor loads were set to verify that each item represented the same concept across gender. Compared to the baseline Model 1 (as reported above), χ^2 increased to 24.20, reaching significance. However, because the significance of χ^2 is easily affected by sample size, we assessed the other fit indices (Cheung & Rensvold, 2002; Johnson et al., 2008). According to the equivalence test (see **Table 4**), both of the Δ CFI and the Δ TLI were 0.002, less than 0.01 (Cheung & Rensvold, 2002). These results indicated that factor loading invariance was established, indicating weak equivalence.

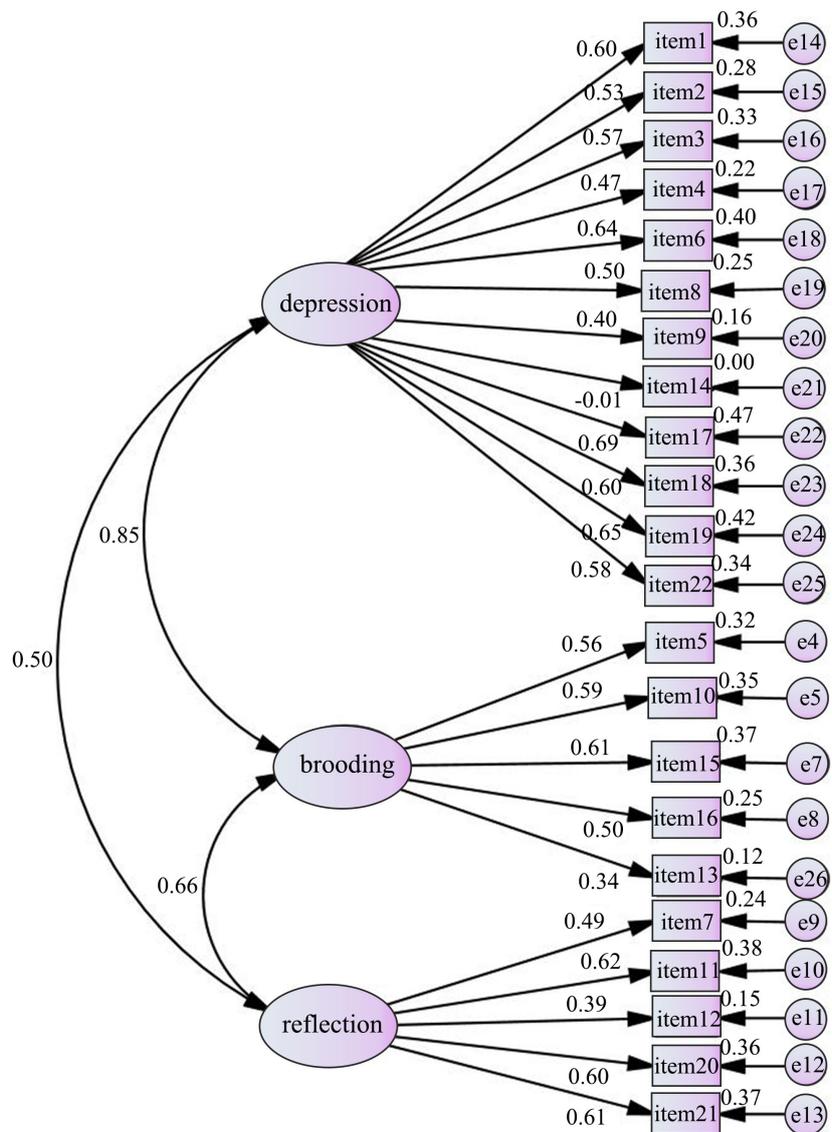


Figure 1. Three-factor structural model of Chinese-ruminative response scale.

Table 1. Descriptive statistical results for each item of the RRS.

Item content	Mean	SD	skew	kurtosis
1) Think about how alone you feel	2.05	0.709	0.774	1.147
2) Think "I won't be able to do my job if I don't snap out of this"	2.09	0.677	0.609	0.928
3) Think about your feelings of fatigue and achiness.	1.87	0.754	0.740	0.534
4) Think about how hard it is to concentrate.	2.29	0.816	0.373	-0.277
6) Think about how passive and unmotivated you feel.	1.91	0.876	0.781	-0.033
8) Think about how you don't seem to feel anything anymore.	1.78	0.831	0.906	0.218
9) Think "Why can't I get going?"	2.12	0.901	0.473	-0.520
14) Think "I won't be able to concentrate if I keep feeling this way."	2.53	0.902	-0.062	-0.769
17) Think about how sad you feel.	1.89	0.849	0.746	-0.025
18) Think about all your shortcomings, failings, faults, mistakes.	2.25	0.830	0.407	-0.284
19) Think about how you don't feel up to doing anything.	2.00	0.857	0.662	-0.085
22) Think about how angry you are with yourself	1.61	0.812	1.290	1.139
5) Think "What am I doing to deserve this?"	1.71	0.826	1.083	0.688
10) Think "Why do I always react this way?"	2.17	0.862	0.395	-0.449
13) Think about a recent situation, wishing it had gone better	2.45	0.864	0.073	-0.650
15) Think "Why do I have problems other people don't have?"	2.14	0.871	0.516	-0.314
16) Think "Why can't I handle things better?"	2.60	0.840	0.065	-0.649
7) Analyze recent events to try to understand why you are depressed.	2.15	0.835	0.378	-0.395
11) Go away by yourself and think about why you feel this way	2.20	0.885	0.405	-0.472
12) Write down what you are thinking and analyze it.	1.80	0.878	0.898	0.008
20) Analyze your personality to try to understand why you are depressed.	2.08	0.864	0.528	-0.315
21) Go someplace alone to think about your feelings	2.17	0.935	0.473	-0.613
Brooding	11.0499	2.73185	0.369	0.196
Reflection	10.3835	2.90140	0.405	-0.022
Depression	24.3781	5.53141	0.667	0.925
Total Scores	45.8114	9.20412	0.489	0.850

Table 2. Goodness-of-fit Indices for RRS model:confirmatory factor analysis (N = 1074).

Goodness-of-fit Indices	χ^2	df	χ^2/df	RMSEA	LO90	HI90	TLI	CFI	GFI
RRQ three factors model	357.432	62	5.765	0.064	0.060	0.073	0.839	0.890	0.867
Adjusted RRQ three factors model	199.925	41	4.876	0.060	0.052	0.069	0.890	0.932	0.914

Table 3. Cronbach's alpha (N = 1102) and inter-subscale correlations; construct reliability (CR) and average variance extracted (AVE) of three subscales.

RRS scale	Cronbach's alpha	Inter-subscale correlations			CR	AVE
		2	3	4		
Depression	0.797	0.638**	0.362**	0.791**	0.693	0.430
Brooding	0.626		0.468**	0.864**	0.659	0.328
Reflection	0.673			0.778**	0.671	0.339
Total scale	0.881					

RRS = Ruminative Response Scale of Chinese version; ** $p < 0.01$.

Table 4. Goodness-of-fit indices and model comparisons for measurement invariance models of gender.

Model	$\chi^2(df)$	χ^2/df	RMSEA (90%CI)	CFI	GFI	TLI	ΔCFI	ΔGFI
Unconstrained	311.185 (102)***	3.051	0.043 (0.038 - 0.049)	0.917	0.932	0.873		
Measurement weights	314.016 (111)***	2.829	0.041 (0.036 - 0.046)	0.919	0.930	0.886	0.002	0.002
Measurement intercepts	322.725 (123)***	2.713	0.039 (0.034 - 0.045)	0.916	0.927	0.894	0.003	0.003
Structural covariances	342.238 (129)***	2.653	0.039 (0.034 - 0.044)	0.915	0.923	0.897	0.001	0.004
Measurement residuals	366.747 (141)***	2.601	0.038 (0.033 - 0.043)	0.910	0.921	0.901	0.005	0.002

*** $p < 0.001$.

The results of the measurement intercepts model showed that intercept equivalence was established, as both ΔCFI and ΔTLI were less than 0.01 (See **Table 4**). Based on the previous model, we tested the structural covariance invariance. The fit indices of model 4 (See **Table 4**) found ΔCFI and ΔTLI equal to 0.002 and 0.000, respectively. Finally, compared with the previous models, the fit index of measurement residual invariance decreased, but the fit indices of measurement residuals invariance were good ($TLI = 0.901$, $CFI = 0.910$, $GFI = 0.921$, $RMSEA = 0.049$), and the ΔCFI and ΔTLI were less than 0.01. The result supported that the strong equivalence also was accepted.

3.5. Factorial Invariance across Age

Multiple-group analysis was used to examine age equivalence of the RRS. All fit indices are listed in **Table 5**. All five models had good fit. The CFIs of all five examined models were approximately 0.9 and the ΔCFI was 0.000. In addition, the TLIs and ΔTLI s were approximately 0.9 and less than 0.01, respectively, indicating good fit.

In summary, the reliability and validity of RRS meet the measurement requirements, and the result also be in accordance with the equivalence of gender and age.

Table 5. Goodness-of-fit indices and model comparisons for measurement invariance models of age.

Model	χ^2 (df)	χ^2 /df	RMSEA (90%CI)	CFI	GFI	TLI	Δ CFI	Δ GFI
Unconstrained	323.290 (153)	2.113	0.044 (0.037 - 0.050)	0.902	0.918	0.873		
Measurement weights	347.490 (171)	2.032	0.042 (0.036 - 0.048)	0.898	0.912	0.882	0.004	0.006
Measurement intercepts	351.378 (176)	1.996	0.41 (0.35 - 0.47)	0.897	0.910	0.887	0.001	0.002
Structural covariances	356.447 (183)	1.948	0.040 (0.034 - 0.046)	0.900	0.911	0.891	0.002	0.001
Measurement residuals	386.961 (207)	1.869	0.039 (0.033 - 0.044)	0.896	0.907	0.900	0.004	0.004

4. Discussion

The data of this research are consistent with normal distribution, and the mean is relatively stable. The exploratory factor analysis of Korean sample of the two-factor RRS demonstrated some different findings in details that the item 16 (Think “Why can’t I handle things better?”) and item 7 (Analyze recent events to try to understand why you are depressed.) were excluded from each subordinate factor (Lee & Kim, 2014). Even the three-factor structural model of Korean-RRS also was different from previous model that depression included 9 items, reflection included 6 items and brooding included 7 items (Shin, Cho, & Kim, 2015). This research also showed that the factor loadings of item 14 was only -0.01 . This difference may be due to the result of different culture. Chinese-RRS of item 14 (Think “I won’t be able to concentrate if I keep feeling this way.”) may be excluded from depression, because Chinese may explain this item as focusing on doing something instead of indulging in these feelings. Cultural differences in language translation and understanding may account for these discrepancies.

Compared with college students (Lei et al., 2017), the middle school students’ academic pressure is relatively greater, which may be related with the immature mental characteristics and the lack of self-adjustment of adolescents. This result also is consistent with the clinical results (Gotham et al., 2018) and associated with the difficulties of social maladjustment, affective recognition, emotion regulation, even suicidal ideation (Sarkisian et al., 2019; Aker, Harmer, & Landrø, 2014).

The results of CFA showed that the structural validity of three factors model of the RRS was acceptable, and most of the factor loading was greater than 0.4, therefore most items on the RRS effectively represent latent variables. However, the item 13 (Think about a recent situation, wishing it had gone better) in the brooding subscale (0.34) and the item 12 (Write down what you are thinking and analyze it) in the reflection subscale (0.39) were not satisfactory. These results was similar with the previous researches of Dutch (Schoofs et al., 2010; Treynor et al., 2003) and other Asian countries (Shin et al., 2015). Previous re-

searches concerning RRS-10's factor analysis have shown a good two-factor structure (Lei et al., 2017; Treynor et al., 2003), however, the validity of the three-factor construct is rarely verified. The revised three-factor model of RRS which excluded the item 14 is also considered to be appropriate which is similar with Korean sample (Shin et al., 2015).

Compared to the USA, Europe, Korean and Japan (Shin et al., 2015, Xavier et al., 2016; Lee & Kim, 2014; Extremera & Fernandez-Berrocal, 2006), the Cronbach's alpha of this study may be somewhat lower but acceptable according to standards of Baker et al (Lee & Kim, 2014). Moreover, compared with college students samples (Lei et al., 2017), the application of RRS on adolescents samples showed higher Cronbach's alpha of the total scale. Except the brooding and reflection subscales, the depression scale also show accepted Cronbach's alpha which is consistent with the related Korean study. Therefore, the reliability of the total scale and three subscales (depression, brooding, and reflection) of the RRS were good to moderate (Evers et al., 2010). Standardized coefficient alpha is identical to the average correlation among k items adjusted by the Spearman–Brown formula, so increasing the number of items and revising items with low loading would yield an expected coefficient alpha.

Inter-subscale correlations are basically in agreement with previous research using the American (Stringars & Goodman, 2013), Japanese (Hasegawa, 2013) and Korean (Shin et al., 2015) versions of the RRS in which the score of total RRS showed higher relationship with depression and brooding, but not reflection. The results of the correlation analysis showed that there was more significant correlation between brooding and depression than reflection. Because brooding is a repetitive negative thought (RNT), some research demonstrated that high levels of RNT were associated with higher negative affect (NA), such as depression and anxiety (Madian et al., 2018). Rumination, but not reflection, was associated with higher mean levels of negative affect (Moberly & Watkins, 2008). Additionally, the current results are similar with those found in another Chinese study. In addition, the correlations between brooding and depression were stronger than those between reflection and depression, which was consistent with previous researches (Schoofs et al., 2010; Treynor et al., 2003). Because brooding as a behavior with negative inhibition, brooding was related to two emotion regulation strategies—suppression and acceptance, which positively associated with other types of suppression and negatively related to acceptance (Liverant et al., 2011; Laina et al., 2018).

Although female demonstrate higher levels of rumination and depression than male, it is unknown whether instruments used to measure rumination and depression have the same psychometric properties for female and male (Nolen-Hoeksema & Girgus, 1994; Gunn & Petersen, 1991). To examine this question, this study evaluated measurement invariance of the RRS by gender. The Chi-square test is easily affected by sample size, such that with an increase in sample size, even small differences may become significant. The CFI, GFI and

TLI were used in the current study as the fit indices because they are not affected by the complexity of the model (Cheung & Rensvold, 2002; Johnson et al., 2008). The previous researches have analyzed the measurement invariance of two-factor-model (GFI = 0.91, CFI = 0.89, TLI = 0.85, RMSEA = 0.08) (50). Some researches also discussed the factorial invariance across different samples, such as different populations and different countries (Lucena-Santos et al., 2018; Arana & Rice, 2017). According to the previous research, the result of the two-factor model suggested that the 10-item version of the RRS provided an assessment of psychometrically equivalent across gender (Whisman et al., 2018). While similar to previous studies, the current results of three-factor model found accepted gender equivalence, the measurement invariance across age was slightly inferior but accepted. This aim of this study were to demonstrate measurement invariance, and to identify and explore sources of heterogeneity (Prince, 2008). The results means that differences in RRS likely reflect valid differences in gender and age.

5. Conclusion

The results of the current study indicate good reliability and validity for application of the three-factor RRS in Chinese adolescents. Three-factor RRS is suitable for the research of depression and related response patterns, such as rumination and reflection in adolescents. However, some modifications are necessary in the depression subscale and other subscales.

Measurement equivalence across gender and age of the three-factor RRS was moderate to good, such that comparisons across gender and age groups are valid. If the difference significance test is carried out, the gender and age differences can be attributed to the differences of the subject variables, rather than the differences caused by the inequivalence of the questionnaire.

It is important to take into consideration some limitations of the current study. Firstly, we used a convenience sample of adolescent from two-provinces in Chinese, so the sample representation needs to be further improved. Secondly, this study relied on one-time self-reported RRS outcomes with no consideration of the potential variety of clinical statuses of the participants (Black & Pössel, 2015).

Author Contributions Statement

Lijuan Liang managed the literature searches, participated in the collection and analysis of data and wrote the manuscript. Yung-Hsing Lee designed the study, participated in the collection and analysis of data, and revised the manuscript. All co-authors have approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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