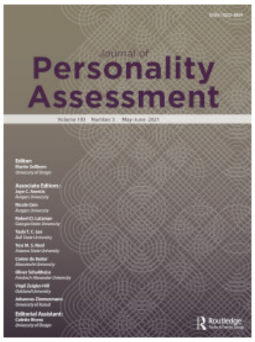

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The Influence of Intolerance of Uncertainty on Anxiety and Depression Symptoms in Chinese-speaking Samples: Structure and Validity of The Chinese Translation of The Intolerance of Uncertainty Scale

Nisha Yao[1,2,3], Mingyi Qian[3], Yi Jiang[1,2], and Jon D. Elhai[4,5]

[1]State Key Laboratory of Brain and Cognitive Science, CAS Center for Excellence in Brain Science and Intelligence Technology, Institute of Psychology, Chinese Academy of Sciences, Beijing, China; [2]Department of Psychology, University of Chinese Academy of Sciences, Beijing, China; [3]School of Psychological and Cognitive Sciences, Beijing Key Laboratory of Behavior and Mental Health, Peking University, Beijing, China; [4]Department of Psychology, University of Toledo, Toledo, Ohio; [5]Department of Psychiatry, University of Toledo, Toledo, Ohio

ABSTRACT

Few studies evaluated the structure of the short versions of the Chinese translation of the Intolerance of Uncertainty Scale (IUS) among Chinese-speaking individuals. Meanwhile, contemporary theory of IU has emphasized the role of IU as the basic transdiagnostic mechanism underlying emotional disorders, and further empirical support is awaited. Thus, the current research aimed to examine the structure of the IUS (Chinese translation) and the hierarchical model of IU. Confirmatory factor analysis was used to compare fit of the two-factor and bifactor models of the original and short versions (IUS-18 and IUS-12) of the IUS (Chinese translation) among Chinese-speaking samples of adults. The direct effects of IU and indirect effects of IU via neuroticism on anxiety and depression symptoms were examined using structural equation modeling. All IUS models demonstrated acceptable fit. Using the bifactor model of the IUS-12 (Chinese translation), the hierarchical model of IU affecting anxiety and depression via neuroticism was supported. The prospective and inhibitory IU factors performed differently in relating to emotional vulnerabilities and symptoms. We provide suggestions for measuring and modeling IU, and the role of IU as the basic transdiagnostic vulnerability was suggested in Chinese-speaking samples.

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Anxiety and depressive disorders are highly prevalent in many countries (Kessler et al., 2007). Specifically, in China, anxiety and depressive disorders are the most and second-most prevalent disorders with the weighted lifetime prevalence of 7.6% and 6.8% (Huang et al., 2019). Considering China's population of 1.3 billion, a large number of individuals suffer from emotional disorders. Identifying key risk factors underlying anxiety and depression would help to inform more efficient interventions and reduce disease burden in China and many other countries. Among various vulnerabilities, intolerance of uncertainty (IU) has been proposed as the basic transdiagnostic construct underlying anxiety and depression (Carleton, 2016a, 2016b). Hence, the current research aimed to examine the applicability of the contemporary theory and measure of IU in a large Chinese-speaking sample. The current findings would enrich the IU literature by providing suggestions for measuring IU among Chinese-speaking individuals and by providing empirical evidence to bolster the role of IU as the fundamental mechanism underlying emotional disorder symptoms.

Relations with psychopathology

The contemporary transdiagnostic definition of IU has proposed that "IU is an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016a, p. 31). Emerging evidence supports the relevance of IU to symptoms of anxiety disorders, obsessive-compulsive disorder (OCD), trauma-related disorder, depression, substance use, and psychosis (Garami et al., 2017; Gentes & Ruscio, 2011; Kraemer, McLeish, & O'Bryan, 2015; Oglesby, Boffa, Short, Raines, & Schmidt, 2016; Shihata, McEvoy, & Mullan, 2017; White & Gumley, 2010). Furthermore, using a transdiagnostic group psychotherapy for emotional disorders, pre- to post-treatment changes in IU predicted symptom amelioration in various anxiety and depressive disorders (Boswell, Thompson-Hollands, Farchione, & Barlow, 2013; Talkovsky & Norton, 2016). Thus, IU is transdiagnostic and transtherapeutic in nature.

Most recently, it was posited that IU is the basic transdiagnostic mechanism underlying emotional vulnerabilities

CONTACT Nisha Yao yaonisha0903@outlook.com Institute of Psychology, Chinese Academy of Sciences, Beijing, 100101, China; Mingyi Qian qmy@pku.edu.cn Philosophy Building, School of Psychological and Cognitive Sciences, Beijing Key Laboratory of Behavior and Mental Health, Peking University, Beijing, 100871.
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and symptoms (Carleton, 2016a, 2016b; Shihata, McEvoy, Mullan, & Carleton, 2016). Specifically, Carleton (2016b) suggested that fear of the unknown (FOTU) is the fundamental fear which underlies higher-order biopsychosocial vulnerabilities, such as neuroticism. Meanwhile, neuroticism is a well-established vulnerability for anxiety and depressive disorders (Barlow, Ellard, Sauer-Zavala, Bullis, & Carl, 2014). A hierarchical structure with FOTU, demonstrated by IU, as the lowest-order construct which explains variance in increasingly higher-order constructs (i.e., neuroticism and emotional disorder symptoms) was then proposed (Barlow et al., 2014; Carleton, 2016a, 2016b). Nevertheless, only a few studies have examined the role of IU as the basic risk factor (Shihata et al., 2017; Wright, Lebell, & Carleton, 2016). Namely, Shihata et al. (2017) observed that trait IU exerted influence on anxiety and OCD symptoms via disorder-specific IU and vulnerabilities (e.g., inflated responsibility); Wright et al. (2016) revealed that the association between IU and health anxiety was mediated by anxiety sensitivity. No doubt, more empirical research based on the theoretical work of Carleton is needed.

Measure of IU and its factorial validity

The Intolerance of Uncertainty Scale (IUS) has been frequently used to assess trait IU (Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994). The original French IUS has been translated into different languages, with validity supported (e.g., English: Buhr & Dugas, 2002; Dutch: de Bruin, Rassin, van der Heiden, & Muris, 2006; Chinese: Yang, 2013). Subsequent research suggested significant redundancy in the full-length 27-item IUS (IUS-27) and a 12-item short version of the IUS (IUS-12) was developed (Carleton, Norton, & Asmundson, 2007). More recently, Hong and Lee (2015) reexamined the IUS' latent structure using exploratory and confirmatory factor analysis (EFA and CFA) and obtained an 18-item version (IUS-18) in a large Asian sample from Singapore. Importantly, Gentes and Ruscio (2011) suggested that the IUS-27 has items specific to GAD-related symptoms, while Khawaja and Yu (2010) compared the performance of the IUS-27 and IUS-12 and suggested that the IUS-12 is a reliable and economical measure of IU. Hence, based on the transdiagnostic definition of IU (Carleton, 2016a), the shorter versions of the IUS are preferable to the full-length version.

Regarding the factor structure of the IUS-27, IUS-18, and IUS-12, they all have yielded a two-factor structure representing prospective and inhibitory IU[1] (Carleton et al., 2007; Hong & Lee, 2015; Sexton & Dugas, 2009). Among the three IUS models, the two-factor IUS-12 has been extensively evaluated in heterogenous samples and received considerable support (Carleton et al., 2012). However, only a few studies have examined the validity of the two-factor IUS-27, providing inconsistent results regarding modeling of the IUS-27 (Fergus & Wu, 2013; McEvoy & Mahoney, 2011; Roma & Hope, 2017), and few have evaluated the IUS-18.

Meanwhile, recent studies suggest a general IU factor and prospective and inhibitory IU group factors underlying IUS items using bifactor CFA (Cornacchio et al., 2018; Hale et al., 2016; Shihata, McEvoy, & Mullan, 2018). It was suggested that bifactor model-based statistical indices can be used to evaluate to what extent group factors explain unique variance beyond the effects of a general factor (Bonifay, Lane, & Reise, 2017; Rodriguez, Reise, & Haviland, 2016a, 2016b). That is, the question has been raised whether prospective and inhibitory IU factors are well-defined latent variables assessing distinct IU-related constructs, and whether prospective and inhibitory IU subscale scores are unique enough to provide "added value" beyond total IU scores (Rodriguez et al., 2016a, 2016b). The extant studies find excellent fit of the bifactor IUS-12 model, and the model-based statistics suggest that the prospective and inhibitory IU group factors explain limited variance beyond the effects of general IU. Accordingly, specifying the general IU factor in a structural model or scoring the total scores of the IUS is encouraged (Shihata et al., 2018).

Applicability in Chinese-speaking samples

Fergus and Wu (2003) have suggested that before assuming generalizability of findings from research on one population to another, the target population should be directly studied (Norton, 2005). Regarding the assessment of IU, Yang (2013) adapted the English version of the IUS-27 (Buhr & Dugas, 2002) into Chinese, evaluated the Chinese translation using EFA, and validated its reliability and validity. Although a four-factor structure was observed, the factor loading patterns differed between Yang's and Buhr and Dugas' studies. Meanwhile, item redundancy of the IUS-27 was suggested (Carleton et al., 2007), and the two-factor or bifactor structure exhibited higher stability as compared to the four-factor structure (Birrell, Meares, Wilkinson, & Freeston, 2011). Yet, a lack of research has reexamined the Chinese translation's factor structure (including the full-length and short versions) using CFA. This has prevented IU research using Chinese-speaking samples from adopting a more appropriate measure or model of IU.

Although the structure of the shorter IUS versions has been extensively studied in North American, European, and Asian samples (Carleton et al., 2012; Hong, 2013; Hong & Lee, 2015), some evidence suggests that Chinese-speaking samples might perform differently in IU-related constructs and thus the generalizability of existing findings to Chinese-speaking samples needs to be investigated. Notably, Yang (2013) reported higher mean IUS-27 total scores in a Chinese-speaking population (71.78 ± 15.13) than in Buhr and Dugas' (2002; 54.78 ± 17.44) sample. A similar pattern could be observed when comparing more recent IU studies

[1]The two factors of the IUS-27 were uncertainty has negative behavioral and self-reference implications (or inhibitory IU; item: 1, 2, 3, 9, 12, 13, 14, 15, 16, 17, 20, 22, 23, 24, 25) and uncertainty is unfair and spoils everything (or prospective IU; item: 4, 5, 6, 7, 8, 10, 11, 18, 19, 21, 26, 27; Sexton & Dugas, 2009). The two factors of the IUS-18 were prospective IU (item: 5, 6, 7, 8, 10, 11, 18, 19, 21) and inhibitory IU (item: 1, 12, 13, 14, 15, 16, 17, 20, 22; Hong & Lee, 2015). The two factors of the IUS-12 were prospective IU (item: 7, 8, 10, 11, 18, 19, 21) and inhibitory IU (item: 9, 12, 15, 20, 25; Carleton et al., 2007).

using Chinese-speaking samples (Chen, Yao, & Qian, 2018; 73.61 ± 17.23 and 77.64 ± 18.45) and Singapore samples where more than 80% of the participants were of Chinese ethnicity (these participants were of English-speaking background and used the English version of the IUS; Hong & Lee, 2015; 63.01 ± 18.80 and 65.57 ± 20.44). Interestingly, although Chinese-speaking samples exhibited higher levels of IU, the strength of correlations between IU and anxiety and depressive symptoms seems to be similar across different samples (e.g., $r = .55 - .60$ in Buhr & Dugas, 2002; $r = .41 - .56$ Yang, 2013). It is important to note that there might be multiple contributors to the above-mentioned differences in IU levels across studies, which should be interpreted with caution. Still, these potential differences in IU between different samples suggests that examining the structure of IU and how IU performs in relating to psychopathology in Chinese-speaking samples is necessary. Further, the role of IU as the basic underlying mechanism of emotional disorder symptoms would be strongly supported if evident in a different cultural group.

The current study

The current research had two primary aims. First, we aimed to evaluate the structure of the shorter versions of the IUS (Chinese translation; Yang, 2013) among Chinese-speaking individuals. As previous research has only examined the four-factor structure of the IUS-27 using EFA in Chinese-speaking samples (Yang, 2013), the current research takes a step forward and examines fit of the two-factor and bifactor IUS-27, IUS-18, and IUS-12 models using CFA in order to inform the assessment and modeling of IU in Chinese-speaking samples. Second, we aimed to examine the hierarchical model of IU affecting neuroticism and anxiety/depressive symptoms in order to bolster the role of IU as the fundamental construct underlying higher-order vulnerabilities and symptoms (Carleton, 2016a, 2016b). We examined the direct and indirect effects of IU via neuroticism on anxiety and depressive symptoms using structural equation modeling (SEM). As only a few studies have examined the hierarchical model of IU with IU as the lowest-order construct (Shihata et al., 2017; Wright et al., 2016), the current research may provide some preliminary empirical evidence supporting contemporary IU theory (Carleton, 2016a, 2016b). We expected that the shorter versions of the IUS would perform better than the full-length version due to reduced item redundancy (Carleton et al., 2007; Hong & Lee, 2015). Regarding the role of IU, we expected that the basic, transdiagnostic nature of IU would manifest in the current Chinese-speaking samples.

Method

Participants

Data from 1402 individuals were collected between January 2018 and March 2019. The current sample consisted of 696 junior college or university students and 707 adults who were not currently in school. Student participants were recruited from two sources: a) individuals participating in experiments irrelevant to the current research and b) an online survey platform that is popular in China: https://www.wjx.cn. The adult sample was recruited from two sources: a) individuals who joined an adult education program and enrolled in weekend courses at a university and b) through the online survey platform. Data from one participant in the non-student adult sample was excluded for responding to all items with the same response. Participants were compensated for course credits or money based on the number of scales they completed. The two-factor and bifactor IUS models were evaluated in the student and non-student adult samples in order to estimate how well these models fit in diverse Chinese-speaking samples.

The student sample (64.51% female) had a mean age of 21.31 ($SD = 2.76$, $range = 18 - 48$), with 17 individuals not reporting age. Participants from the student sample had a bachelor's degree or below (86.93%) or master's degree or beyond (13.07%). Meanwhile, the adult sample comprised 66.71% females and had a mean age of 30.64 ($SD = 6.28$, $range = 20 - 66$), with 2 individuals not reporting age. The education level composition of the adult sample was as follows: bachelor's degree or below (93.91%), master's degree or beyond (6.09%). Individuals who were unemployed constituted 6.09% of the adult sample. As expected, the mean age, $t(971.28) = -35.97$, $p < .001$, Cohen's $d = -1.92$, and education level, $\chi^2(1, N = 1402) = 19.78$, $p < .001$, Cramer's $V = .12$, differed significantly between the student sample and adult sample, while gender composition, $\chi^2(1, N = 1402) = .75$, $p = .39$, Cramer's $V = .02$, did not differ between groups. To examine the hierarchical model of IU (Carleton, 2016a, 2016b), all participants completed the IUS-27 and Penn State Worry Questionnaire (PSWQ), while some completed the neuroticism subscale of the Revised Eysenck Personality Questionnaire Short Scale (EPQ-RS), Beck Anxiety Inventory (BAI), Generalized Anxiety Disorder Scale-7 (GAD-7), and Beck Depression Inventory (BDI). All measures were in Chinese and were delivered via online survey methods.

Measures

Intolerance of uncertainty

The IUS (Buhr & Dugas, 2002; Freeston et al., 1994) is a 27-item scale assessing negative beliefs about and reactions to uncertainty. Each item is rated on a 5-point Likert scale (1 = *not at all characteristic of me*; 5 = *entirely characteristic of me*). The 27-item IUS shows excellent psychometric properties in both nonclinical and clinical samples (Khawaja & Yu, 2010; Sexton & Dugas, 2009). The IUS-12 (Carleton et al., 2007) and the IUS-18 (Hong & Lee, 2015) are highly correlated with the original IUS-27 and their total and subscale scores demonstrate strong convergent and discriminant validity. The reliability and validity of the Chinese translation of the IUS-27[2] have been supported (Yang, 2013). Descriptive statistics of the IUS were as follows: student sample ($n = 696$), mean (SD) = 81.27 (15.81), skewness =

[2]The current research used the Chinese translation of the IUS-27 validated by Yang (2003). We acquired the Chinese translation by email from Dr. Yang and had his permission for using the scale in our research.

−.07, kurtosis = −.45, α = .89; non-student sample (n = 706), mean (*SD*) = 79.38 (19.32), skewness = −.12, kurtosis = −.47, α = .93.

Worry

The PSWQ (Meyer, Miller, Metzger, & Borkovec, 1990) is a 16-item scale designed to measure generality, excessiveness, and uncontrollability of worry. Each item is rated on a Likert scale ranging from 1 (*not at all typical of me*) to 5 (*very typical of me*). The Chinese version has good reliability and validity (Zhong, Wang, Li, & Liu, 2009). Descriptive statistics of the PSWQ using the entire sample (n = 1402) were as follows: mean (*SD*) = 41.28 (10.54), skewness = .06, kurtosis = −.36, α = .91.

Anxiety

The BAI (Beck, Epstein, Brown, & Steer, 1988) measures severity of anxiety symptoms, especially physiological symptoms and panic sensations. The BAI contains 21 items, each of which describes an anxiety symptom (e.g., 'shaky') and is rated on a 4-point scale (0 = *not at all*; 3 = *severely, I could barely stand it*). The psychometric properties of the Chinese version are supported (Wang, Wang, & Ma, 1999). Descriptive statistics of the BAI (n = 1026) were as follows: mean (*SD*) = 9.39 (8.93), skewness = 1.75, kurtosis = 3.67, α = .92. The GAD-7 (Spitzer, Kroenke, Williams, & Löwe, 2006) is a brief screening tool for GAD. The GAD-7 has 7 items rated on a 4-point scale (0 = *not at all*; 3 = *nearly every day*). The Chinese version has acceptable internal consistency, discriminant and convergent validity (He, Li, Qian, Cui, & Wu, 2010). Descriptive statistics of the GAD-7 (n = 1026) were as follows: mean (*SD*) = 4.40 (4.21), skewness = 1.32, kurtosis = 1.81, α = .89.

Depression

The BDI (Beck, Steer, & Carbin, 1996) is a 21-item scale measuring severity of depressive symptoms. Each item contains 4 self-evaluative statements rated from 0 to 3 describing normal responses and mild, moderate, and severe depression symptoms. The Chinese version has acceptable reliability and validity (Wang et al., 1999). Descriptive statistics were as follows (n = 838): mean (*SD*) = 11.10 (9.17), skewness = 1.08, kurtosis = 1.01, α = .92.

Neuroticism

The EPQ-RS (Eysenck & Eysenck, 1991) contains four subscales measuring extraversion, neuroticism, psychoticism, and social desirability. The EPQ-RS has 48 items, which are answered dichotomously using "yes" or "no" ratings. The psychometric properties of the EPQ-RS for Chinese are supported (Qian, Wu, Zhu, & Zhang, 2000). The 12-item neuroticism subscale (EPQ-N) was employed in the current study. Descriptive statistics of the EPQ-N were as follows (n = 1026): mean (*SD*) = 5.85 (3.55), skewness = .04, kurtosis = −1.03, α = .84.

Analytic strategy

CFA was used to examine the factor structure of the IUS' full-length and short versions using Mplus 8.3. The weighted least square estimator with chi-square correction of means and variances (WLSMV) was adopted. Because of five response options, in CFA we treated IUS items as ordinal, involving a polychoric covariance matrix and probit factor loadings. The two-factor and bifactor models of the IUS-27 (Sexton & Dugas, 2009), IUS-18 (Hong & Lee, 2015), and IUS-12 (Carleton et al., 2007; Hale et al., 2016; Shihata et al., 2018) were examined in the student sample (n = 696) and the non-student adult sample (n = 706). Furthermore, the bifactor statistical indices were calculated (Rodriguez et al., 2016a, 2016b).

Model fit was evaluated using several fit indices[3]: the comparative fit index (CFI), Tucker-Lewis fit index (TLI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA). Values of CFI and TLI equal to or greater than .95 are considered good, while values between .90 and .95 are acceptable (Bentler, 1992; Hu & Bentler, 1999). SRMR should be less than .08. RMSEA values less than .06 indicate excellent fit and values between .06 and .08 are acceptable (Browne & Cudeck, 1993; Hu & Bentler, 1999). Further, the upper limit of the 90% confidential interval (CI) of RMSEA should be less than .10.

For the bifactor model, omega and omega hierarchical (ω and ω_H) values were calculated to inform model-based reliability of the total and subscale scores. Omega estimates the proportion of variance in observed total scores accounted by all sources of common variance, while ω_H quantifies the proportion of variance accounted by the general factor after controlling for effects of group factors. Similarly, omega for each subscale (ω_S) estimates the proportion of variance in observed subscale scores accounted by common variance, while ω_H for each subscale (ω_{HS}) quantifies the proportion of variance attributable to the group factor after controlling for the general factor (Rodriguez et al., 2016a). A ω_H value close to or above .75 suggests that total scores could be used as a reliable measure of the general IU factor (Reise, Bonifay, & Haviland, 2013).

Construct reliability (H) was calculated to inform how reliably a set of items represents a latent variable. A standard criterion of H equals to .70 indicated that a latent variable is represented well and thus is useful in a structural model (Rodriguez et al., 2016a, 2016b). Furthermore, explained common variance (ECV) and percent of uncontaminated correlations (PUC) were calculated to inform to what extent is the scale unidimensional enough and thus could be specified as a unidimensional model with acceptable parameter bias. ECV for the general factor (ECV_{gen}) quantifies the proportion of common variance across all items explained by the general factor. PUC estimates the percentage of item correlations that only reflects variance attributable to general factor. As PUC increases (PUC > .80), the magnitude of ECV_{gen} becomes

[3]The current research used the WLSMV estimator, so the information criterion indices (e.g., the Expected Cross-Validation Index) could not be calculated.

Table 1. Model fit indices for the two-factor and bifactor models of the IUS-27, IUS-18, and IUS-12 in the student and non-student samples.

Model	χ^2	df	CFI	TLI	SRMR	RMSEA [90% CI]	Diff Test	$\Delta\chi^2$(df)	*p*-value
1. IUS-27a; two-factor	1272.11	323	.91	.90	.055	.065 [.061 − .069]			
2. IUS-27a; bifactor	954.59	297	.94	.93	.046	.056 [.052 − .060]	1 vs. 2	307.45 (26)	<.001
3. IUS-27b; two-factor	1513.80	323	.94	.93	.047	.072 [.069 − .076]			
4. IUS-27b; bifactor	1130.03	297	.96	.95	.039	.063 [.059 − .067]	3 vs. 4	382.99 (26)	<.001
5. IUS-18a; two-factor	513.99	134	.93	.93	.048	.064 [.058 − .070]			
6. IUS-18a; bifactor	373.80	117	.96	.94	.039	.056 [.050 − .063]	5 vs. 6	135.20 (17)	<.001
7. IUS-18b; two-factor	654.44	134	.96	.95	.042	.074 [.069 − .080]			
8. IUS-18b; bifactor	478.47	117	.97	.96	.034	.066 [.060 − .072]	7 vs. 8	174.21 (17)	<.001
9. IUS-12a; two-factor	277.09	53	.90	.88	.048	.078 [.069 − .087]			
10. IUS-12a; bifactor	183.29	42	.94	.91	.038	.070 [.059 − .080]	9 vs. 10	96.06 (11)	<.001
11. IUS-12b; two-factor	312.77	53	.95	.94	.041	.083 [.075 − .092]			
12. IUS-12b; bifactor	177.34	42	.98	.96	.030	.068 [.057 − .078]	11 vs. 12	138.85 (11)	<.001

Note. a = the student sample (n = 696); b = the non-student sample (n = 706). CFI = comparative fit index; TLI = Tucker-Lewis fit index; SRMR = standardized root mean square residual; RMSEA = root mean square error of approximation.

Table 2. Bifactor model-based statistical indices of the IUS-27, IUS-18, and IUS-12.

		Student				Non-student				
		ω	ω_H	H	ECV	ω	ω_H	H	ECV	PUC
IUS-27	General	.92	.82	.92	.76	.95	.91	.96	.85	.51
	Prospective	.81	.01	.38	.06	.88	.07	.55	.07	
	Inhibitory	.89	.24	.68	.19	.93	.08	.57	.09	
IUS-18	General	.87	.74	.87	.68	.93	.83	.93	.77	.53
	Prospective	.72	.01	.37	.08	.85	.08	.64	.10	
	Inhibitory	.85	.34	.66	.24	.90	.23	.57	.13	
IUS-12	General	.79	.74	.82	.76	.88	.83	.90	.82	.53
	Prospective	.61	.09	.34	.11	.77	.13	.61	.15	
	Inhibitory	.74	.07	.35	.13	.83	.02	.15	.03	

Note. General = general IU factor; Prospective = prospective IU group factor; Inhibitory = inhibitory IU group factor. ω = omega; ω_H = omega hierarchical; H = construct reliability; ECV = explained common variance; PUC = percent uncontaminated correlations.

less important for estimating parameter bias; if PUC values were lower than .80, ECV_{gen} and ω_H above .60 and .70 could be regarded as a criterion suggesting acceptable bias when forcing a multidimensional instrument into a unidimensional model (Reise, Scheines, Widaman, & Haviland, 2013).[4]

Subsequently, the measurement models of the PSWQ, BAI, GAD-7, BDI, and EPQ-N were assessed using CFA (WLSMV estimator; see Supplementary Materials). SEM was used to examine the relationship between IU, neuroticism, and anxiety/depression-related symptoms using the entire sample (WLSMV estimator; BOOTSTRAP = 1000). Based on the recent theoretical model suggesting IU as the fundamental construct underlying neuroticism and emotional disorder symptoms (Carleton, 2016a, 2016b), IU was treated as the independent variable, with neuroticism regressed on IU and anxiety/depression symptoms regressed on IU and neuroticism.

Results

Confirmatory factor analysis

The two-factor models with a prospective and inhibitory IU factor were evaluated in both the student and non-student adult samples (Table 1). Results revealed no significant difference in model fit between the two-factor solutions of the IUS-27, IUS-18, and IUS-12. Specifically, values of the model fit indices were generally acceptable for all three two-factor solutions, and the 90% CIs of RMSEA overlapped across the various two-factor models in each sample (the two-factor model cannot be statistically compared across versions using difference testing, as the three IUS versions are non-nested).

Bifactor models of the IUS-27, IUS-18, and IUS-12 characterized by a general IU factor and a prospective and inhibitory IU group factor were examined in both the student and non-student samples (Table 1). Similarly, no significant difference between the three bifactor solutions in model fit was observed in each sample (again, these versions are non-nested and cannot be compared statistically). Specifically, in the student sample, the bifactor IUS-27, IUS-18, and IUS-12 exhibited acceptable fit. In the non-student sample, the three bifactor models yielded excellent fit except for the slightly inflated values of RMSEA (> .06), while the upper limit of the 90% CIs of RMSEA did not exceed .08. As revealed by the significant chi-square difference ($ps < .001$; using Mplus's DIFFTEST command), bifactor models fit the current data better than the two-factor solutions.

Further, bifactor model-based statistical indices were calculated for the IUS-27, IUS-18, and IUS-12 (Table 2). Based on omega reliability statistics, in both samples, more than 73% of the variance in total IUS (the full-length and short versions) scores can be attributed to the general IU factor, whereas less than 35% of the variance in subscale scores was explained by the prospective or inhibitory IU group factor. Hence, across various versions of the IUS, the total scores' variance was predominantly explained by general IU and thus total scores could be regarded as a reliable index of

[4]The above-mentioned bifactor statistical indices were calculated based on the adapted Mplus syntax of Hammer and Toland (2016).

Table 3. Structural model examining the relationship between IU and psychopathological symptoms within a bifactor framework.

	General IU factor				Prospective IU factor				Inhibitory IU factor				Neuroticism			
	β	SE	*p*	*95% CI*	*β*	SE	*p*	*95% CI*	*β*	SE	*p*	*95% CI*	*β*	SE	*p*	*95% CI*
EPQ-N	**.69**	**.03**	**<.001**	**[.65, .73]**	−.09	.06	.14	[−.20, −.01]	**.23**	**.07**	**<.01**	**[.10, .33]**				
PSWQ	**.49**	**.05**	**<.001**	**[.41, .56]**	.04	.06	.44	[−.04, .14]	**.13**	**.05**	**.01**	**[.06, .22]**	**.47**	**.06**	**<.001**	**[.38, .55]**
GAD	**.14**	**.07**	**.03**	**[.04, .25]**	−.07	.06	.23	[−.19. −.01]	−.20	.07	.01	[−.34, −.10]	**.67**	**.07**	**<.001**	**[.56, .78]**
BAI	.05	.08	.56	[−.08, .17]	−.12	.07	.12	[−.26, −.03]	−.28	.08	<.01	[−.44, −.17]	**.61**	**.09**	**<.001**	**[.48, .74]**
BDI	**.15**	**.07**	**.02**	**[.04, .28]**	−.12	.07	.11	[−.28, −.04]	−.13	.08	.09	[−.29, −.02]	**.60**	**.08**	**<.001**	**[.47, .72]**

Note. EPQ-N = Eysenck Personality Questionnaire-Neuroticism Subscale; PSWQ = Penn State Worry Questionnaire; GAD = Generalized Anxiety Disorder Scale; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory. The covariance between the method factor of PSWQ and other factors was fixed to zero (see measurement model of the PSWQ in supplementary materials). Coefficients in bold indicated that the associations were significant with 95% CIs excluding zeros.

general IU. However, subscale scores' variance was also mainly accounted by the general IU factor, suggesting that the calculation of subscale scores provided limited added value beyond the calculation of total scores.

Construct reliability was examined. In both samples, we observed high H values for the general IU factor (Hs > .81), whereas H values of the group factors fell below .69. This pattern of results suggested that the construct reliability of the prospective and inhibitory IU group factors was less acceptable than that of the general IU factor. Finally, we calculated ECV_{gen} and PUC. The PUC value suggested that more than 50% of the item correlations reflected the general IU factor. Meanwhile, ECV_{gen} values suggest that more than 67% of the common variance across items were explained by the general factor. As ECV_{gen} values were above .60 and ω_H values were above .70 in both samples, these results suggest that the IUS could be modeled as unidimensional with limited parameter bias when specifying an SEM measurement model (Reise, Bonifay, et al., 2013).

Based on the CFA results, the two- and bi-factor models of the IUS-27, IUS-18, and IUS-12 were all justified and could be used confidently among Chinese-speaking individuals. Nevertheless, given that the IUS-27 has significant item redundancy and contains items specific to GAD symptoms (Gentes & Ruscio, 2011; Khawaja & Yu, 2010), the shorter versions are more concise and can better reflect the transdiagnostic essence of IU (Carleton, 2016a, 2016b). Furthermore, the IUS-12 is widely used in IU research and has normative data across different populations as compared to the IUS-18 (Carleton et al., 2012). Hence, using the IUS-12 as a measure of IU in Chinese-speaking samples is preferable. The current mean (*M*) and standard deviation (*SD*) of the IUS-12 were as follows: college/university students, $M = 37.21$, $SD = 7.02$, skewness = .04, kurtosis = −.45; non-student adults, $M = 36.64$, $SD = 8.53$, skewness = −.13, kurtosis = −.28. The correlations between the IUS-12 and related vulnerabilities and symptoms were as follows: EPQ-N, $r = .55$, PSWQ, $r = .68$, GAD-7, $r = .45$, BAI, $r = .33$, BDI, $r = .42$.

Hierarchical model of IU

Based on the recent theoretical model of IU (Carleton, 2016a, 2016b), we examined the relationship between IU, neuroticism, and anxiety/depression-related symptoms using the entire sample. As the current research aimed to examine how IU related to higher-order vulnerabilities and symptoms, the bifactor IUS-12 model was used and the effects of general IU were the focus. Meanwhile, the two-factor IUS-12 model showed acceptable fit, and the bifactor model-based statistical indices suggest that a unidimensional measurement model of IU in structural model introduces limited parameter bias. We therefore examined different structural models using the two-factor and one-factor models of IU and compared these structural models in terms of model fit and estimation results. In general, these analyses yielded a similar pattern of results as the findings in the bifactor framework and were thus reported in the supplementary materials.

The structural model using bifactor IUS-12 model exhibited good fit ($\chi^2 = 7554.24$, $df = 3785$, CFI = .95, TLI = .95, SRMR = .059, RMSEA [90% CI] = .027 [.026 − .028]). The general IU factor was significantly and positively associated with neuroticism and anxiety and depression symptoms (except for physiological anxiety symptoms/panic sensations measured by the BAI), while neuroticism associated with all symptoms significantly (Table 3). For the group factors, only inhibitory IU exhibited meaningful associations with neuroticism and worry, while the remaining associations were non-significant and/or demonstrated a pattern contrary to the theory-based hypotheses (i.e., negative rather than positive correlations; Carleton, 2016a). The model explained 81% (i.e., R^2 values for latent variables) of variance in worry, 43.7% in physiological anxiety symptoms and panic sensations, 59.3% in generalized anxiety, 51.4% in depression, and 53.7% in neuroticism ($ps < .001$). This structural model is visualized in Figure 1 with only significant and meaningful paths depicted.

Subsequently, the indirect effects of IU on symptoms through neuroticism were examined. Similarly, general IU exhibited significant indirect effects on worry (*Estimate* = .32, *SE* = .04, $p < .001$, 95% CI [.26, .38]), generalized anxiety (*Estimate* = .46, *SE* = .06, $p < .001$, 95% CI [.38, .55]), physiological anxiety symptoms/panic sensations (*Estimate* = .42, *SE* = .06, $p < .001$, 95% CI [.32, .52]), and depression (*Estimate* = .41, *SE* = .06, $p < .001$, 95% CI [.32, .50]). Furthermore, inhibitory IU showed significant yet weak indirect effects on worry (*Estimate* = .11, *SE* = .03, $p < .01$, 95% CI [.05, .16]), generalized anxiety (*Estimate* = .15, *SE* = .06, $p = .01$, 95% CI [.06, .25]), physiological anxiety symptoms/panic sensations (*Estimate* = .14, *SE* = .06, $p = .01$, 95% CI [.05, .23]), and depression (*Estimate* = .14, *SE* = .05, $p = .01$, 95% CI [.05, .21]). Prospective IU exhibited nonsignificant indirect effects. These results bolstered the

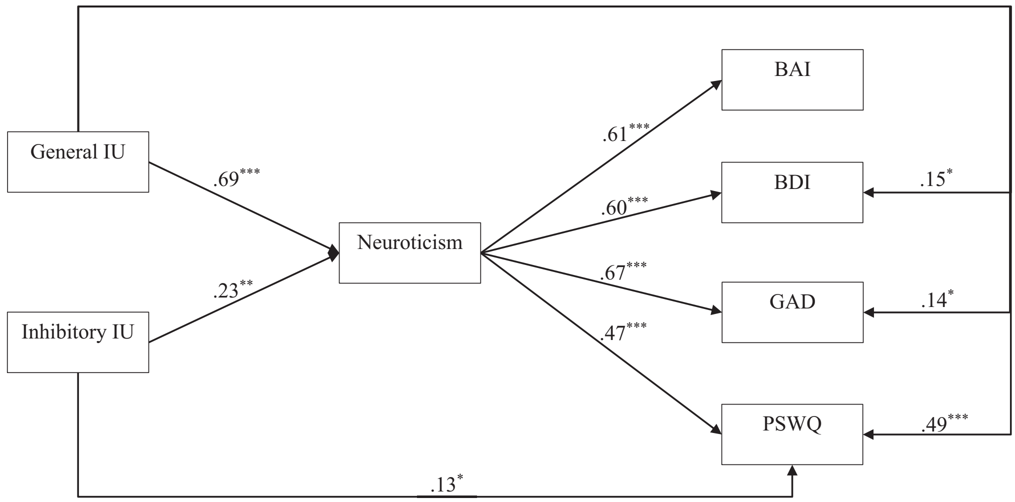

Figure 1. Hierarchical model of IU affecting neuroticism and anxiety/depression symptoms. BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; GAD = Generalized Anxiety Disorder Scale; PSWQ = Penn State Worry Questionnaire. Only estimates that were meaningful and significant with their 95% CIs excluding zeros were depicted to maintain clarity. **p* <.05; ***p* <.01; ****p* <.001.

role of IU as the lower-order construct affecting higher-order vulnerability and symptoms in a hierarchical structure (Carleton, 2016a, 2016b).

Discussion

The first aim of the current research was to examine the structure of the Chinese translation of the IUS. In either the college/university student sample or non-student adult sample, fit of the two-factor or bifactor IUS-27, IUS-18, and IUS-12 models were generally acceptable and did not differ significantly (Carleton et al., 2007; Hong & Lee, 2015; Sexton & Dugas, 2009). Given that there is significant redundancy and some items are specific to GAD-related symptoms in the IUS-27, assessing IU using shorter versions of the IUS would be more consistent with the contemporary transdiagnostic definition of IU (Carleton, 2016a; Gentes & Ruscio, 2011; Khawaja & Yu, 2010). Comparing the two shorter versions, the IUS-12 has been widely used since its development and there were accumulative normative data in heterogeneous samples for the IUS-12 (e.g., Carleton et al., 2012; Cornacchio et al., 2018; Fergus & Wu, 2013). Hence, we suggest that the Chinese translation of the IUS-12 is preferable for IU research using Chinese-speaking samples.

Comparing the current descriptive statistics of the IUS-12 (Chinese translation) in college/university students and non-student adults to normative data provided by Carleton et al. (2012), we observed that the current student and non-student samples had higher means of the IUS-12 total scores than in Carleton et al.'s undergraduate and community samples. Meanwhile, the strength of correlations between IU and general symptoms of anxiety and depression was comparable in the current sample and the Carleton et al. (2007) sample. The same pattern emerged when comparing Yang's (2013) finding and Buhr and Dugas' (2002). It would be interesting for future IU research to concurrently compare the Chinese-speaking samples and Western samples.

In alignment with previous research (Cornacchio et al., 2018; Hale et al., 2016; Shihata et al., 2018), the bifactor IUS-12 fit better than the two-factor IUS-12 (Chinese translation). Further, in a bifactor framework, the current findings provide evidence supporting a general IU factor underlying all items of the IUS-12 (Chinese translation), and the model-based reliability for measuring general IU was high. In contrast, prospective and inhibitory IU group factors yielded low reliability after controlling for the effects of general IU. Based on these results, using the IUS-12 (Chinese translation) total scores was supported, while scoring the subscale scores may have limited added value (Hale et al., 2016). Furthermore, specifying a unidimensional IUS-12 measurement model in a structural model is acceptable; if a bifactor IUS-12 is used, the observed associations involving the group factors should be interpreted with caution (Shihata et al., 2018). Still, it is important to note that bifactor models tend to overfit the data and standard fit indices may be biased to support the bifactor models (Bonifay et al., 2017). Hence, modeling IU in a way that better fits the research goal is of importance. For instance, if examining the difference between prospective and inhibitory IU in relating to psychopathology is the goal, the two-factor model is preferable; if examining the role of trait IU is the focus, the unidimensional or bifactor model can be used (see Supplementary Materials for model comparison results).

The second aim of the current research was to examine the hierarchical model of IU based on the contemporary IU theory (Carleton, 2016a, 2016b). Consistent with our hypotheses, general IU was significantly associated with neuroticism and emotional disorder symptoms, which is in line with a large number of studies indicating that IU is closely related to a wide range of vulnerabilities and symptoms (Allan et al., 2018; Hong, 2013; Mathes et al., 2017; McEvoy & Mahoney, 2012; Shihata et al., 2017). Although the current research is cross-sectional and causal inferences are not appropriate, the current findings of IU affecting symptoms via neuroticism provide empirical support for the contemporary theory of IU, suggesting that IU exerted influence on higher-order vulnerabilities and symptoms in a hierarchical structure (Carleton, 2016a, 2016b). Specifically, it is reasonable to suggest that enhanced IU interacted with, or even contributed to, increased neuroticism (i.e., "the tendency to experience frequent, intense negative emotions associated with a sense of uncontrollability in response to stress"; Barlow et al., 2014, pp. 481), leading to increased worry, anxiety, and depressive symptoms.

Consistent with Shihata et al. (2017), when the effect of intermediary vulnerability was considered, the direct effect of general IU on panic sensations and cognitions was not significant. Regarding the relationship between IU and panic symptoms, some research observed a robust association (e.g., Boswell et al., 2013), while others have failed to observe a significant association (e.g., Hong, 2013). It is possible that general IU affected panic symptoms in a hierarchical order where more specific vulnerabilities (i.e., neuroticism in the current research; panic disorder-specific IU and agoraphobic cognitions in Shihata et al.'s) played a crucial mediating role. Future IU research with a longitudinal design can assist in verifying the current findings.

Although the model-based reliability of the prospective and inhibitory IU group factors was limited in a bifactor framework and discerning between prospective and inhibitory IU is beyond the scope of the current research, we observed that inhibitory IU, rather than prospective IU, exerted weak yet significant effects on symptoms through neuroticism. A similar pattern of results emerged using the two-factor IUS-12 model (see Supplementary Materials). Consistently, Shihata et al. (2018) observed significant though weak effects of inhibitory IU on anxiety and depression, suggesting that the group factors functioned differently. On a theoretical level, it has been proposed that prospective and inhibitory IU reflect an approach and avoidance-based orientation in facing uncertainty respectively, and inhibitory IU is the more maladaptive aspect of IU (Birrel et al., 2011; Hong & Lee, 2015). The current results and Shihata et al.'s supported this perspective. Nevertheless, as the current research included limited measures of personality and psychopathology, this prohibited differentiating between the effects of prospective and inhibitory IU on approach and avoidance-related vulnerabilities and symptoms (Hong & Lee, 2015). Future research may benefit from including a broader range of measures (e.g., behavioral inhibition/activation; metacognition).

The current findings have some implications. First, the full-length and short versions of the IUS (Chinese translation) can all be confidently used in Chinese-speaking samples; the IUS-12 is preferable when the transdiagnostic nature of IU is the focus. Second, scoring the total scores or modeling the general IU factor in a structural model is supported. Third, prospective and inhibitory IU show low construct reliability and limited added value beyond the effects of general IU in a bifactor framework, yet they may still represent different aspects of IU and have clinical implications. Thus, future research examining the effects of prospective and inhibitory IU on the development and maintenance of symptoms using a longitudinal design would provide critical evidence suggesting whether or not it is necessary to consider these two different aspects of IU in clinical work (Cornacchio et al., 2018). Fourth, given that the two-factor IUS-12 model had acceptable fit and is parsimonious, research focusing on the distinctions between prospective and inhibitory IU can adopt the two-factor model. Fifth, we provided empirical evidence supporting the hierarchical model of IU, and the role of IU as the fundamental construct underlying neuroticism, anxiety, and depression is further bolstered (Carleton, 2016a, 2016b).

The current research has limitations. First, we recruited nonclinical participants to attain a large enough sample, yet generality to clinical samples is unknown. Future research may replicate the current research in both clinical and nonclinical samples. Second, the current research adopted a cross-sectional design, so causal inferences cannot be made when the hierarchical model of IU was examined. Future research using a longitudinal design and measuring IU, neuroticism, and symptoms with time lags in between is needed. Third, the current research only included general measures of anxiety and depression, so the discriminant validity of the Chinese translation of the IUS could not be examined. Fourth, the current research solely relied on self-report measures. Future research may consider adopting multiple methods as suggested in the Research Domain Criteria (Kozak & Cuthbert, 2016). Finally, the current research did not take into consideration other anxiety/depression-related symptoms (e.g., social anxiety) and intermediary vulnerabilities (e.g., anxiety sensitivity; behavioral avoidance; fear of negative evaluation; negative metacognitions). Future research should include additional measures to advance the understanding of how IU explains higher-order variance through divergent trajectories (Shihata et al., 2017).

Notwithstanding these limitations, the current research contributed to the IU literature by examining the structure of the Chinese translation of the IUS using CFA, which had implications for measuring and modeling IU among Chinese-speaking individuals. Further, the current research supported the contemporary theory of IU (Carleton, 2016a, 2016b), suggesting that IU affected higher-order constructs in a hierarchical structure. Accordingly, the role of IU as the fundamental transdiagnostic construct underlying neuroticism, anxiety and depressive symptoms is suggested in a Chinese-speaking population. Future research clarifying how IU exerts influence on divergent symptoms via multiple intermediary vulnerabilities using a longitudinal design is awaited in order to better understand the role of IU in the etiology and maintenance of psychopathology.

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ORCID

Nisha Yao http://orcid.org/0000-0002-6117-5694

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